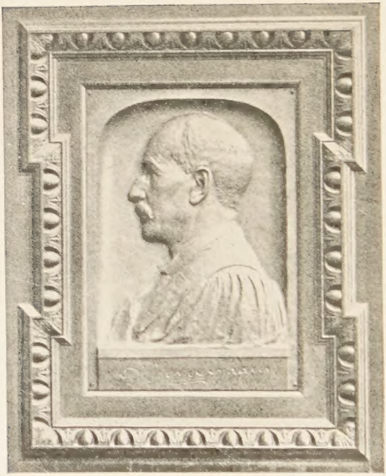
MANUAL OF ANATOMY



DANIEL JOHN CUNNINGHAM

Demonstrator of Anatomy, University of Edinburgh, 1874–1882
Professor of Anatomy, Royal College of Surgeons, Dublin, 1882–1883
Professor of Anatomy, Trinity College, University of Dublin, 1883–1903
Professor of Anatomy, University of Edinburgh, 1903–1909

From identical Bronze Plaques in the Dissecting Rooms, Trinity College, Dublin, and the University of Edinburgh

CUNNINGHAM'S MANUAL

OF

PRACTICAL ANATOMY

REVISED AND EDITED BY

J. C. BRASH

PROFESSOR OF ANATOMY IN THE UNIVERSITY OF EDINBURGH

AND

E. B. JAMIESON

LECTURER ON ANATOMY IN THE UNIVERSITY OF EDINBURGH

NINTH EDITION

VOLUME FIRST

GENERAL INTRODUCTION

UPPER LIMB LOWER LIMB

WITH 44 RADIOGRAPHS AND 159 OTHER ILLUSTRATIONS, MANY OF WHICH ARE COLOURED

NEW YORK

OXFORD UNIVERSITY PRESS

LONDON EDINBURGH GLASGOW TORONTO

MELBOURNE CAPE TOWN BOMBAY

CALCUTTA MADRAS SHANGHAI

Dissector's Guide, 1879
Manual of Practical Anatomy, 1889
Present Series
1st Edition, 1896 — D. J. CUNNINGHAM.
2nd Edition, 1903
3rd Edition, 1906
4th Edition, 1907

Revised, 1910
5th Edition, 1912
6th Edition, 1914
2nd Impression, 1917
3rd Impression, 1918
7th Edition, 1920 — ARTHUR ROBINSON.
2nd Impression, 1921
3rd Impression, 1925
8th Edition, 1927
Revised, 1930
2nd Impression, 1934

9th Edition, 1935
2nd Impression, 1937

Printed in Great Britain by R. & R. CLARK, LIMITED, *Edinburgh.*

PREFACE TO THE NINTH EDITION

With this edition of *Cunningham's Manual of Practical Anatomy* there is a change in editorship. The last edition prepared by the original author was the fourth published in 1907. That edition was re-issued in 1910, revised by Professor Arthur Robinson, whose last editorial work, before his retirement in 1931, was a revision of the Eighth Edition.

When this edition was called for, we undertook the task of revision with some misgiving lest we should fail to keep up the standard set by our predecessors the one a master of fluent prose, the other unexcelled in knowledge of anatomical detail—and we ask for some indulgence from those who are familiar with their work.

The character of the book as a dissector's guide remains unaltered, but we have thought it advisable to make certain changes which we hope will bring the student's work in the dissecting-room into still closer relation with his study of the living body, and will further emphasise the kind of knowledge expected of him in his clinical work.

We have increased the stress laid on the importance of the relations of structures to the surface of the body, have reversed the relative emphasis laid on arteries and nerves, and have given a fuller account of lymph drainage. We have made more frequent reference to function and to the application of anatomical facts in the diagnosis and treatment of disease.

By referring to observations on the living body, we have also tried to correct the impressions of the form and position

of viscera which the dissector obtains from the embalmed cadaver. Most of the illustrations of X-ray Anatomy have been replaced by radiographs in negative reproduction, such as the student sees in demonstrations and in clinical practice.

We are aware that our most important reader is the student who has not dissected the part before, and one of our aims has been to lighten his task. We have therefore given him, in Volume I., a General Introduction to the structures met with in a dissection, and, throughout, have striven to avoid putting information before him at a stage when he cannot understand it. To this end, we have eliminated descriptive detail from the dissection directions and have, in some places, substituted preliminary explanations of the positions and characters of structures to which reference must be made in the early stages of dissection. We have also found it necessary in certain parts —Lower Limb, Head and Neck, and Abdomen—to alter the sequence of description in order to make a more consecutive narrative; in the Pelvis, in addition, we have given the female equal rights with the male, in order that the dissector of the female pelvis should not be at a disadvantage. The sequence of dissection—altered in accordance—is as easily carried out as that formerly in use.

In some regions, the advances of Surgery have made it necessary to amplify the description; and we have added descriptions of certain important parts that had been omitted from the former editions, but are within the range of easy dissection—for example, the Air Sinuses.

In general, however, we have aimed at reducing the amount of detail that the student is called upon to learn. The reduction in size in each volume is greater than is apparent from the pagination, for many of the former plates are now paged.

We have replaced the Basle Nomina Anatomica by the anglicised version of a revision of that nomenclature which was adopted by the Anatomical Society at Birmingham in 1933. The advantage of the use of this revision is twofold: it is accepted by all British teachers; and the anglicised form makes the text easier to read and more easily understood by

the dissector—who is the reader for whom the book is primarily written. For the sake of those already familiar with the Basle terms, we have inserted a glossary of the names in the Birmingham Revision that differ radically from the B.N.A.; the "N.K." equivalents of these are also included.

Most of the old illustrations have been retained unchanged, but a few have been omitted, some have been coloured, and others have been replaced; and a number of entirely new figures have been added. The new illustrations are partly figures taken from *Cunningham's Text-book of Anatomy* (and we take this opportunity of thanking the authors of the sections from which they come) and partly new drawings by Mr. Charles E. Pierce, whose skill, we believe, will be acknowledged by our readers. Some of the new radiographs have been prepared by Dr. E. Ll. Godfrey in this Department; for others, we are indebted to Dr. J. F. Brailsford and Dr. J. Duncan White; and, for three special head radiographs reproduced in Volume III., our thanks are due to Mr. Norman M. Dott.

J. C. B.
E. B. J.

DEPARTMENT OF ANATOMY,
UNIVERSITY OF EDINBURGH.
June 1935.

CONTENTS

GLOSSARY

The first column gives the anglicised version of those terms in the Birmingham Revision which differ radically from Basle Nomina Anatomica.

The second column gives the corresponding Basle names.

The third column gives the corresponding names suggested by the German Nomenklatur-Kommission where these names differ from the B.N.A.

General Terms and Parts of Human Body

B. R.	B. N. A.	N. K.
Cephalic	Cranialis	
Anterior and palmar	Volaris	
Upper limb	Extremitas superior	Extremitas thoracica
Lower limb	Extremitas inferior	,, pelvina
Supra-sternal fossa	Fossa jugularis	
Infra-clavicular fossa	Trigonum deltoideo-pectorale	
Epigastric fossa	Scrobiculus cordis	
Palm of hand	Vola manus	

OSTEOLOGY

Pedicle of vertebral arch	Radix arcus vertebræ	
Laminæ ,, ,,	*Omitted*	
Axis vertebra	Epistropheus	
Odontoid process	Dens	
Spinous tubercles of sacrum	Crista sacralis media	
Transverse tubercles of sacrum	Cristæ sacrales laterales	
Articular tubercles of sacrum	,, ,, articulares	
Inlet of thorax	Apertura thoracis superior	A. t. cranialis
Outlet ,,	Apertura thoracis inferior	,, caudalis
Supra-sternal notch	Incisura jugularis	
Condylar part of occipital bone	Pars lateralis	

B. R.	B. N. A.	N. K.
Posterior condylar canal	Canalis condyloideus	C. condylicus
Anterior ,, ,,	,, hypoglossi	
Optic groove	Sulcus chiasmatis	
Palatino-vaginal canal	Canalis pharyngeus	
Vomero-vaginal canal	,, basi-pharyngeus	
Hiatus for greater superficial petrosal nerve	Hiatus canalis facialis	
Auditory meatus	Meatus acusticus	
Squamo-tympanic fissure	Fissura petro-tympanica	
Articular fossa (of temporal bone)	Fossa mandibularis	Fossa mandibularis (Facies articularis)
Nasal spine (of frontal bone)	Spina frontalis	Spina nasalis os. fr.
Orbital plate (of ethmoid)	Lamina papyracea	
Dental foramina	Foramina alveolaria	
Naso-lacrimal groove	Sulcus lacrimalis	
Alveolar arch	Limbus alveolaris	Margo alveolaris
Greater palatine groove	Sulcus pterygopalatinus	
Tubercle of palatine bone	Processus pyramidalis	
Genial tubercles	Spina mentalis	Spinæ mandibulares
Submandibular fossa	Fovea submaxillaris	
Impressions for gyri	Impressiones digitatæ	
Greater palatine canal	Canalis pterygopalatinus	
Bony anterior aperture of nose	Apertura piriformis	
Posterior aperture of nose	Choana	
Supra-scapular notch	Incisura scapulae	
Spino-glenoid notch	*Omitted*	
Impression for costo-clavicular ligament	Tuberositas costalis	
Conoid tubercle, Trapezoid ridge	Tuberositas coracoidea	
Bicipital groove of humerus	Sulcus intertubercularis	
Lateral lip	Crista tuberculi majoris	
Medial lip	,, ,, minoris	
Spiral groove	Sulcus n. radialis	
Trochlear notch of ulna	Incisura semilunaris	
Scaphoid bone	Os naviculare manus	Os radiale
Trapezium	Os multangulum majus	Os carpale distale I
Trapezoid	,, ,, minus	,, ,, ,, II
Ramus of ischium	Ramus inferior ossis ischii	Pars pubica rami ossis ischii
Pectineal line	Pecten ossis pubis	
Iliopubic eminence	Eminentia ilio-pectinea	
False pelvis	Pelvis major	
True ,,	,, minor	
Arcuate line	Linea terminalis	
Inlet of pelvis	Apertura superior	Aditus pelvis
Outlet ,,	,, inferior	Exitus ,,

B. R.	B. N. A.	N. K.
Intercondylar area of tibia	Fossæ intercondyloideæ	Fossa intercondylica plantaris; Fossa intercondylica dorsalis
Soleal line	Linea poplitea	
Styloid process of fibula	Apex capituli fibulæ	
Posterior border ,,	Crista lateralis	
Anterior surface ,,	Facies medialis (pars anterior)	
Posterior surface ,,	Facies posterior; Facies medialis (pars posterior)	Facies plantaris
Medial and posterior tubercles of talus	Processus posterior tali	Tubercula mediale et laterale processus posterioris tali
Lateral tubercle of calcaneum	Processus lateralis tuberis calcanei	Tuberculum laterale tuberis calcanei
Medial tubercle of calcaneum	Processus medialis tuberis calcanei	Tuberculum mediale tuberis calcanei

JOINTS

Fibrous joint	Synarthrosis	
Flat suture	Sutura harmonia	(Harmonia)
Primary cartilaginous joint	Synchondrosis	
Secondary cartilaginous joint	Amphiarthrosis	
Synovial joint	Diarthrosis	
Plane joint	Arthrodia	
Ball and socket joint	Enarthrosis	Enarthrosis sphæroidea
Capsular ligament	Stratum fibrosum capsulæ articularis	
Intervertebral discs	Fibro-cartilagines intervertebrales	Disci intervertebrales
Lateral costo-transverse lig.	Lig. tuberculi costæ	
Inferior costo-transverse lig.	,, colli costæ	Lig. colli costæ caudale; ,, ,, ,, jugale
Superior costo-transverse lig.	,, costo-transversarium anterius	Lig. costo-transversarium internum
Manubrio-sternal joint	Synchondrosis sternalis	Symphysis sterni
Supra-scapular lig.	Lig. transversum scapulæ superius	Lig. transversum scapulæ
Spino-glenoid lig.	Lig. transversum scapulæ inferius	*Omitted*
Palmar ligs. of fingers	Ligg. accessoria volaria	
Deep transverse ligs. of palm	Ligg. capitulorum transversa	
Acetabular labrum	Labrum glenoidale	Labium articulare

B. R.	B. N. A.	N. K.
Lig. of head of femur	Lig. teres femoris	
Semilunar cartilages of knee	Menisci	
Inferior tibio-fibular joint	Syndesmosis tibio-fibularis	
Inferior tibio-fibular ligs.	Ligg. malleoli lateralis	Ligg. tibio-fibularia dorsale et plantare
Short plantar lig.	Lig. calcaneo-cuboideum plantare	
Plantar ligs. of toes	Ligg. accessoria plantaria	
Deep transverse ligs. of sole	Ligg. capitulorum transversa	

MUSCLES

B. R.	B. N. A.	N. K.
Tendinous intersection	Inscriptio tendinea	
Synovial sheath of tendon	Vagina mucosa tendinis	
,, bursa	Bursa mucosa	
Ilio-costo-cervicalis	Ilio-costalis	
Ilio-costalis	Ilio-costalis lumborum	
Costalis	,, dorsi	
Costo-cervicalis	,, cervicis	
Longissimus thoracis	Longissimus dorsi	
Spinalis ,,	Spinalis ,,	
Semispinalis ,,	Semispinalis ,,	
Lumbar fascia	Fascia lumbo-dorsalis	
Occipito-frontalis	Epicranius	M. occipitalis M. frontalis
Epicranial aponeurosis	Galea aponeurotica	
Compressor naris Dilatator ,,	Nasalis	
Depressor anguli oris	Triangularis	
Zygomaticus major	Zygomaticus	Zygomaticus major
,, minor	Caput zygomaticum (Quadratus labii superioris)	,, minor
Levator labii superioris	Caput infra-orbitale (Quadratus labii superioris)	Levator nasi et labii maxillaris lateralis
Levator labii superioris alæque nasi	Caput angulare (Quadratus labii superioris)	Levator nasi et labii medialis
Depressor labii inferioris	Quadratus labii inferioris	Quadratus labii mandibularis
Levator anguli oris	Caninus	
Anterior intercostal membranes	Ligg. intercostalia externa	
Posterior intercostal membranes	Ligg. intercostalia interna	
Transversus thoracis		
Sterno-costalis	Transversus thoracis	
Innermost intercostals		
Subcostals	Subcostales	

B. R.	B. N. A.	N. K.
Vertebral part of diaphragm	Pars lumbalis	
Crus	Crus laterale ,, intermedium ,, mediale	
Arcuate ligaments	Arcus lumbo-costales	
Arcuate line	Linea semicircularis [Douglasi]	
Pectineal part of inguinal lig.	Lig. lacunare [Gimbernati]	
Reflected part of inguinal lig.	Lig. inguinale reflexum	
Conjoint tendon	Falx aponeurotica inguinalis	
Superficial inguinal ring	Annulus inguinalis subcutaneus	
Deep ,, ,,	Annulus inguinalis abdominalis	Annulus inguinalis præperitonealis
Bulbo-spongiosus	Bulbo-cavernosus	
Perineal membrane	Fascia diaphragmatis urogenitalis inferior	F.d.u. externa
Omitted	Diaphragma urogenitale	
Clavi-pectoral fascia	Fascia coraco-clavicularis	F. coraco-clavi-pectoralis
Bicipital aponeurosis	Lacertus fibrosus	
Palmar interossei	Interossei volares	
Extensor retinaculum	Lig. carpi dorsale	
Flexor ,,	,, ,, transversum	
Flexor digitorum accessorius	Quadratus plantæ	
Subsartorial canal	Canalis adductorius [Hunteri]	
Saphenous opening	Fossa ovalis	
Extensor retinacula	Lig. transversum cruris ,, cruciatum ,,	Lig. cruciforme Lig. fundiforme
Flexor retinaculum	Lig. laciniatum	
Bursa of psoas major	Bursa ilio-pectinea	
Tibial intertendinous bursa	,, m. sartorii propria ,, anserina	

NEUROLOGY

Spinal cord	Medulla spinalis	
White columns	Funiculi	
Grey columns (Horns in section)	Columnae	C. ventralis C. lateralis C. dorsalis
White commissure	Commissura anterior alba	C. ventralis alba

B. R.	B. N. A.	N. K.
Grey commissure	Commissura anterior grisea Commissura posterior	C. grisea [C. posterior]
Thoracic nucleus	N. dorsalis (Stillingi; Clarki)	
Intersegmental tracts	Fasciculi proprii	
Anterior spino-cerebellar tract	Fasc. antero-lateralis superficialis (Gowersi)	
Posterior spino-cerebellar tract	Fasc. cerebello-spinalis	
Inferior cerebellar peduncle	Corpus restiforme	Crus medullo-cerebellare
Gracile tubercle	Clava	
Middle cerebellar peduncle	Brachium pontis	Crus ponto-cerebellare
Sensory decussation	Decussatio lemniscorum	
Olivary nucleus	Nucleus olivaris inferior	N. olivæ
Dorsal N. of corpus trapezoideum	,, ,, superior	N. olivaris metencephali
Olivo-cerebellar tract	Fibræ cerebello-olivares	Tractus olivo-cerebellares
Superior cerebellar peduncle	Brachium conjunctivum	Crus cerebello-cerebrale
Floor of fourth ventricle	Fossa rhomboidea	Fossa rhomboides
Vagal triangle	Ala cinerea	
Vestibular area	Area acustica	Area vestibularis
Auditory striæ	Striæ medullares	
Tectum	Lamina quadrigemina	
Quadrigeminal bodies	Colliculi	Colliculi rostrales ,, caudales
Aqueduct of mid brain	Aquæductus cerebri (Sylvii)	Aquæductus mesencephali
Interthalamic connexus	Massa intermedia	
Stria habenularis	Stria medullaris thalami	
Pre-central gyrus	Gyrus centralis anterior	G. fronto-centralis
Post-central gyrus	,, ,, posterior	G. parieto-centralis
Post-central sulcus Intra-parietal sulcus	Sulcus interparietalis	
Paraterminal gyrus	Gyrus subcallosus	
Supra-splenial sulcus	Sulcus subparietalis	
Isthmus of gyrus cinguli	Isthmus g. fornicati	
Medial occipito-temporal gyrus	Gyrus fusiformis	G. occipito-temporalis lateralis
Occipito-temporal sulcus	Sulcus temporalis inferior	S. temporalis basialis
Olfactory pyramid	Trigonum olfactorium	
Pes hippocampi	Digitationes hippocampi	
Dentate gyrus	Fascia dentata hippocampi	Gyrus dentatus
Splenial gyrus	Fasciola cinerea	G. fasciolaris

B. R.	B. N. A.	N. K.
Anterior column of fornix	Columna fornicis	
Posterior ,, ,,	Crus ,,	
Stria semicircularis	Stria terminalis	
Association fibres	Fibræ arcuatæ cerebri	
Optic radiation	Radiatio occipito-thalamica [Gratioleti]	
Cranial nerves	Nervi cerebrales	
Sensory root of 5th N.	Portio major	
Motor root of 5th N.	,, minor	
Trigeminal ganglion	Ganglion semilunare [Gasseri]	
Ganglionic branches of maxillary N.	Nn. spheno-palatini	Nn. pharyngo-palatini
Superior dental nerves	Nn. alveolares superiores	Nn. alveolares maxillares, aborales, medius et orales
Inferior dental nerve	N. alveolaris inferior	N. alveolaris mandibularis
Short spheno-palatine nerves	Nn. nasales superiores posteriores	Rami nasales aborales
Long spheno-palatine nerve	N. naso-palatinus (Scarpæ)	
Greater palatine nerve	N. palatinus anterior	N. palatinus major
Lesser palatine nerves	Nn. palatini medius et posterior	N. pal. medius et minor
Submandibular ganglion	Ganglion submaxillare	G. submandibulare
Sensory root of 7th nerve	N. intermedius	
Auditory nerve	N. acusticus	N. stato-acusticus
Inferior ganglion of 9th nerve	G. petrosum	G. extracraniale
Superior ganglion of 10th nerve	G. jugulare	
Inferior ganglion of 10th nerve	G. nodosum	
Anterior cutaneous nerve of neck	N. cutaneus colli	
N. to rhomboids	N. dorsalis scapulæ	
N. to serratus anterior	N. thoracalis longus	N. thoracicus longus
Pectoral nerves	Nn. thoracales anteriores	Nn. thoracici ventrales
N. to latissimus dorsi	N. thoraco-dorsalis	
Circumflex nerve	N. axillaris	
Radial nerve	N. radialis et ramus superficialis	
Posterior interosseous nerve	Ramus profundus	
Gluteal branches of lumbar nerves	Nn. clunium superiores	Nn. clunium craniales
Femoral branch of genito-femoral nerve	N. lumbo-inguinalis	

B. R.	B. N. A.	N. K.
Genital branch of genito-femoral nerve	N. spermaticus externus	
Lateral popliteal nerve	N. peronæus communis	N. fibularis communis
Sural communicating branch	Ramus anastomoticus peronæus	R. anast. fibularis
Musculo-cutaneous n.	N. peronæus superficialis	N. fibularis superficialis
Anterior tibial n.	,, profundus	N. fibularis profundus
Medial popliteal n. } Posterior tibial n. }	N. tibialis	
Sural nerve	N. cutaneus suræ medialis / N. suralis	N. cutaneus suræ tibialis

SENSE ORGANS

B. R.	B. N. A.	N. K.
Optic disc	Papilla n. optici	Papilla optica
Fascial sheath of eyeball	Fascia bulbi	Capsula bulbi
Lacrimal canaliculi	Ductus lacrimales	Ductuli lacrimales
Aqueduct of cochlea	Ductus perilymphatici	
Roof of tympanum	Paries tegmentalis	
Floor of ,,	,, jugularis	
Medial wall of tympanum	,, labyrinthicus	
Anterior wall of ,,	,, caroticus	
Posterior wall of ,,	,, mastoideus	
Lateral wall of ,,	,, membranaceus	
Pharyngo-tympanic tube	Tuba auditiva (Eustachii)	

BLOOD VASCULAR SYSTEM

B. R.	B. N. A.	N. K.
Annulus ovalis	Limbus fossæ ovalis	
Infundibulo-ventricular crest	Crista supra-ventricularis	
Infundibulum	Conus arteriosus	
Pulmonary valve	Valvulæ semilunares a. pul.	Valvula a. pulmonalis
Right cusp	V. semilunaris anterior	Velum semilunare sinistrum
Posterior cusp	V. semilunaris dextra	Velum semilunare dextrum
Aortic valve	Valvulæ semilunares aortæ	Valvula aortæ
Left cusp	V. s. posterior	Velum semilunare dextrum
Anterior cusp	V. s. sinistra	Velum semilunare sinistrum
Pulmonary trunk	A. pulmonalis	
R. pulmonary art.	Ramus dexter	
L. pulmonary art.	,, sinister	
Innominate art.	A. anonyma	Truncus brachio-cephalicus
Facial art.	A. maxillaris externa	A. facialis

B. R.	B. N. A.	N. K.
Maxillary art.	A. maxillaris interna	A. maxillaris
Inferior dental artery	A. alveolaris inferior	A. alveolaris mandibularis
Superior dental arteries	Aa. alveolares superiores	Aa. alveolares maxillares orales et aborales
Greater palatine artery	A. palatina descendens	
Superior and inferior palpebral arches	Arcus tarsei superior et inferior	Arcus tarsei frontalis et maxillaris
Supra-trochlear art.	A. frontalis	A. frontalis medialis
Supra-scapular art.	A. transversa scapulæ	
Ulnar collateral art.	A. collateralis ulnaris superior	A. coll. uln. proximalis
Supra-trochlear art.	A. collateralis ulnaris inferior	,, ,, distalis
Radialis indicis art.	A. volaris indicis radialis	
Palmar arches	Arcus volares	
Phrenic artery	A. phrenica inferior	A. phrenica abdominalis
Superior left colic artery	A. colica sinistra	
Inferior left colic arteries	Aa. sigmoideæ	
Rectal arteries	A. hæmorrhoidales	Aa. rectales, cranialis et caudalis et A. analis
Internal iliac artery	A. hypogastrica	A. ilica interna
Art. of vas deferens	A. deferentialis	
Art. to cremaster Art. to lig. teres uteri	A. spermatica externa	
Descending genicular art.	A. genu suprema	
Inferior vena hemiazygos	V. hemiazygos	V. thoracica longitudinalis sinistra
Superior ,, ,,	V. hemiazygos accessoria	V. thoracica longitudinalis accessoria
Innominate veins	Vv. anonymæ	Vv. brachio-cephalicæ
Transverse sinus Sigmoid sinus	Sinus transversus	
Thalamo-striate vein	V. terminalis	
Supra-scapular vein	V. transversa scapulæ	
Internal iliac vein	V. hypogastrica	V. ilica interna
Rectal veins	Vv. hæmorrhoidales	*See arteries*
Prostate plexus	Plexus pudendalis	P. vesico-pudendalis
Left gastric vein Right ,,	V. cononaria	
Superior left colic vein	V. colica sinistra	
Inferior left colic veins	Vv. sigmoideæ	

LYMPHATIC SYSTEM

Submandibular lymph glands	Lymphoglandulæ submaxillares	Lymphonodi submandibulares
Supra-trochlear lymph glands	Lymphoglandulæ cubitales superficiales	

B. R.	B. N. A.	N. K.
Aortic lymph glands	Lymphoglandulæ lumbales	
Internal iliac lymph glands	Lymphoglandulæ hypogastricæ	
Superficial inguinal lymph glands	Lymphoglandulæ inguinales; Lymphoglandulæ subinguinales superficiales	L. inguinales superficiales
Deep inguinal lymph glands	Lymphoglandulæ subinguinales profundæ	L. inguinales profundi

DIGESTIVE SYSTEM

B. R.	B. N. A.	N. K.
Oro-pharyngeal isthmus	Isthmus faucium	
Submandibular gland	Gl. submaxillaris	Gl. submandibularis
,, duct	Ductus ,,	Ductus ,,
Dentine (Ivory)	Substantia eburnea	
Enamel	,, adamantina	
Cement	,, ossea	
Pharyngo-epiglottic fold	Plica glosso-epiglottica lateralis	
Tonsil (*The*)	Tonsilla palatina	
Intra-tonsillar cleft	Fossa supra-tonsillaris	
Naso-pharyngeal tonsil	Tonsilla pharyngea	
Ileo-colic valve	Valvula coli	
Vermiform appendix	Processus vermiformis	
Descending colon	Colon descendens	
Pelvic colon	,, sigmoideum	Colon sigmoides
Rectum	Intestinum rectum	
Anal canal	Pars analis recti	
Sacculations of colon	Haustra coli	
Horizontal folds of rectum	Plicæ transversales recti	
Anal columns	Columnæ rectales (Morgagnii)	
,, sinuses	Sinus rectales	
Lesser sac of peritoneum	Bursa omentalis	
Opening into lesser sac	Foramen epiploicum	
Pelvic meso-colon	Meso-colon sigmoideum; Meso-rectum	Meso-sigmoideum
Infundibulo-pelvic lig.	Lig. suspensorium ovarii	Plica suspensoria ovarii

RESPIRATORY SYSTEM

B. R.	B. N. A.	N. K.
Posterior apertures of nose	Choanæ	
Subvomerine cartilage	Cart. vomero-nasalis	
Upper nasal cartilage	,, nasi lateralis	Lamina dorsi nasi (cartilaginis septo-dorsalis)

B. R.	B. N. A.	N. K.
Lower nasal cartilage	Cart. alaris major	C. apicis nasi
Crico-vocal membrane	Conus elasticus	
Vestibular lig.	Lig. ventriculare	
,, fold	Plica ventricularis	
Sinus of larynx	Ventriculus laryngis (Morgagnii)	
Saccule of larynx	Appendix	
Cervical pleura	Cupula pleuræ	
Recesses of pleura	Sinus pleuræ	
Costo-diaphragmatic recess	,, phrenico-costalis	

UROGENITAL ORGANS

Pelvis of ureter	Pelvis renalis	
Spongy part of urethra	Pars cavernosa urethrae	
Fossa terminalis	Fossa navicularis (Morgagnii)	
Corpus spongiosum penis	Corpus cavernosum urethræ	
Bulb of penis	Bulbus urethræ	
Vestige of vaginal process	Rudimentum proc. vag.	
Internal spermatic fascia	Tunica vaginalis communis	
Vas deferens	Ductus deferens	
Arbor vitæ of uterus	Plicæ palmatæ	
Vestibular fossa	Fossa navicularis	

MANUAL

OF

PRACTICAL ANATOMY

GENERAL INTRODUCTION

FOR descriptive purposes the HUMAN BODY is divided into *Head*, *Neck*, *Trunk and Limbs*. The trunk is subdivided into the Chest or *Thorax* and the Belly or *Abdomen*; the abdomen is further subdivided into the *Abdomen Proper* and the *Pelvis*; and the lower end of the trunk, where the pelvis comes to the surface between the buttocks and between the thighs, is called the *Perineum*.

Many students begin to dissect before they have attended an introductory course in Anatomy; many of the terms used in a dissecting guide are, therefore, quite new to the dissectors; and they will find it a great convenience to learn the meanings of those terms before they begin.

Terms of Position. During dissection, the body, or any detached portion of it, usually lies horizontally on a table; but the dissector must remember that descriptive terms which refer to position are used as though the body were standing upright, with the eyes looking horizontally forwards, and the upper limbs hanging by the sides but so rotated that the palms of the hands are directed forwards. This attitude is known as the "anatomical position."

Superior or upper, therefore, does not refer to the position of a part that is nearer the dissector as he looks down on his dissection, but refers to the position of a part that is *nearer*

the head of the supposedly erect body ; and **inferior** means *nearer the feet.*

Anterior means nearer the front of the body, and **posterior** means nearer the back. In the trunk, *ventral* is sometimes used instead of anterior, and *dorsal* instead of posterior. (*Venter* = the belly ; *dorsum* = the back). In the hand, *dorsal* commonly replaces posterior, and *palmar* replaces anterior ; in the foot, the corresponding surfaces are superior and inferior in the anatomical position, but those terms are usually replaced by *dorsal* (*dorsum* of foot) and *plantar.* (*Planta* = the sole).

The **median plane** is an imaginary plane that divides the body into a right and a left half. The **anterior** and **posterior median lines** are the edges of that plane on the front and the back of the body. The term **median** usually refers to the position of a structure that is bisected by the median plane. **Medial** means nearer the median plane, and **lateral** means farther away from that plane. The usual English words with those meanings are *inner* and *outer*, or their equivalents (derived from the Latin) *internal* and *external.* But these English words mean also nearer the interior of a structure and farther away from the interior ; in anatomical descriptions we confine them to that meaning, and replace them by " medial " and " lateral " when we are thinking of relative distance from the median plane. External and internal (or outer and inner) are seldom used in the description of the structures in the limbs, for the words in common use are **superficial** for nearer the skin, and **deep** for farther away from it.

A plane through any portion of the body parallel to the median plane is called **sagittal**, and any vertical plane at right angles to these is called **coronal** (from the position of two of the sutures of the skull).

Proximal and **distal** are terms that signify *nearer to* some point agreed upon and *farther from* that point. In a limb, the point agreed upon is the root of the limb ; therefore, in a limb, " proximal " and " distal " mean the same as " superior " and " inferior," except in the foot.

Middle, or its Latin equivalent *medius*, is the usual adjective denoting a position between upper and lower or between anterior and posterior, but **intermediate** is commonly used instead of " middle " for a position between lateral and medial.

Structures met with in a Dissection.—The first step in a dissection is the removal of the skin. That discloses the superficial fascia.

The **superficial fascia** is a fibrous, fatty covering that underlies the skin and is attached by fibrous strands to the skin. In the scalp, the back of the neck, the palms of the hands, and the soles of the feet, its attachment to the skin is very firm. In all other parts it is loose enough to allow the skin to be freely moved; and its elasticity enables it to bring the skin back into place again. The thickness of the superficial fascia depends upon the quantity of fat in its meshes, and therefore varies greatly in different bodies and in different parts of the same body; fat is absent from the parts of it that underlie the skin of the eyelid, the nipple and areola of the breast, and some parts of the external genital organs.

The deeper parts of the glands of the skin and of the roots of the hairs penetrate into the superficial fascia; and the *mammary gland*, which is composed of modified and enlarged skin glands, is developed in it.

In some regions—for example, in the groin—the deeper part of the superficial fascia is in the form of a distinct membranous layer. In two regions, its deeper part contains a thin sheet of muscle—(1) in the front and side of the neck and the adjacent part of the chest, where the sheet of muscle is called the *platysma*; and (2) in the scrotum, where it is called the *dartos*.

The superficial fascia is a warm garment underneath the skin, for fat is a bad conductor of heat. When moderately fatty, it fills up the hollows and rounds off the irregularities at the surface of the body. In a muscular man, however, it is seldom thick enough to obscure the outlines of the muscles that lie near the surface, whereas it is usually thick enough to do so in women. The rounded contours and smooth outlines of a woman's figure, due to the greater quantity of fat in the superficial fascia, are a secondary sex character.

The superficial fascia contains not only the fat and the other structures mentioned already, but also the cutaneous blood vessels, lymph vessels, and nerves on their way to and from the skin; and a few lymph glands are embedded in it.

Blood vessels are of three kinds—arteries, veins, and capillaries.

The **arteries** are the tubes that convey blood from the

heart. Before the body is brought into the dissecting room, it is embalmed by the injection of a preservative liquid into the arteries, and that is usually followed by the injection of coloured starch which distends the arteries and simulates the scarlet blood of arteries, making the smaller ones more apparent for dissection. Arteries branch and re-branch like trees. But, unlike trees, many of their branches join one another, forming tubular loops. The union of branches of arteries is called an **anastomosis**. The largest artery in the body is the *aorta*, which springs from the heart. It is about an inch in diameter. The largest artery of a limb is one-quarter or one-third of an inch in diameter. The branches are successively narrower and narrower ; and those in the superficial fascia are so slender that the red injection seldom runs into them.

The **veins** are the tubes that carry the blood back to the heart. They are wider and more numerous than the arteries. They usually retain their blood after death, and are therefore bluish or purple in colour. The lesser veins unite, like the tributaries of a river, to form the larger veins. The veins anastomose even more freely than the arteries do. Every artery in a limb is accompanied by at least one vein. Most of the superficial arteries and all the larger deep arteries are accompanied by a single vein ; the smaller deep arteries have two veins, one on each side, called **venæ comitantes**, united by channels that cross the artery. But, in the superficial fascia, there are numerous veins that do not accompany arteries ; they are fairly large, and a good view of them and their anastomoses may be had through the skin in the living forearm.

The **blood-capillaries** are microscopic tubes that complete the circulatory system by forming a network in which the smallest branches of arteries end and the smallest tributaries of veins begin.

The pumping action of the heart sends the blood through the arteries and capillaries and onwards through the veins. The force of the heart beat is, however, becoming spent by the time it reaches the veins ; the more sluggish flow of blood in them is aided by the movements of the muscles among which they lie—one of the important benefits of taking moderate exercise—and also by the indraw of breath, for the enlargement of the chest with each inspiration draws

venous blood into it as well as air. None the less, the flow in veins is liable to be retarded by slight impediments; and most veins, therefore, have valves to prevent or hamper any tendency to backward flow of the blood. The position of the valves of the superficial veins of one's own forearm can be seen if these veins are compressed at the elbow; the veins then become distended with blood, and the position of the valves is indicated by little, localised swellings or "beads."

The **lymph glands** are nodules that vary in size from a pin-head to a large bean; and they are factories in which microscopic bodies called the white blood-corpuscles are made. It is sometimes difficult to distinguish the smaller glands from the pellets of fat amidst which they lie; but they are firmer in consistence, and though they vary in colour —purple, grey, brown, black—they are seldom yellow like fat. In the limbs, they are largest and most numerous in the armpit and in the groin. Lymph glands are found usually in groups of three or four; the groups are named after the places where they lie; and it often occurs that several groups are linked together by lymph vessels.

The **lymph vessels** are very fine tubes that contain a clear liquid called **lymph**. The lymph is exuded from the blood in the blood capillaries, and permeates all the tissues of the body. The chief constituents of nearly every tissue are microscopic bodies or cells. These cells take up from the lymph the oxygen and foodstuffs which they require, and give up to it the products of their activities, which, for the most part, return to the blood. The lymph is thus a "middle-man" between the tissue cells and the blood in the blood-capillaries. During increased activity of any organ or part of the body, the exudation of lymph from the blood-capillaries also increases in that part; and a system of lymph vessels is required for carrying off the excess which otherwise would accumulate in the tissues. The supply of lymph depends therefore on the activity of a part. There is a constant flow in the lymph vessels that drain the alimentary canal in the abdomen, some part of which is nearly always at work; but from parts that are sometimes at rest, *e.g.*, the limbs, the flow is intermittent.

The lymph is collected from the tissues by a network of fine vessels, called **lymph capillaries**, which are wider than blood capillaries and are less regular in shape. They differ

also in that they communicate with larger vessels in only one direction, whereas blood capillaries receive their contents from one set of larger vessels and pass them on to another. The smaller lymph vessels arise from the capillary network, and carry the lymph to a lymph gland, where they end. The lymph passes through the gland, and is collected by other lymph vessels that arise in the gland. These vessels carry it onwards either to another gland or to a larger lymph vessel. The vessels that carry lymph to a gland are called *afferent* vessels; those that carry it from a gland are *efferent*. (*Ad* = to; *ex* = from; *fero* = carry). As the glands are linked together, the efferent vessels of one gland are often the afferent vessels of another. The glands that receive afferent vessels direct from a part of the body are known as the "primary" glands of that part. The larger lymph vessels unite together like the veins to form wider and wider vessels, but the resulting main lymph channels are no larger than small veins. The lymph is ultimately poured into the blood stream, for the largest lymph vessels (the longest and widest of which is called the *thoracic duct*) end by joining the great veins at the root of the neck.

There is no pumping force, like that of the heart, to drive the lymph onwards. Its flow through the lymph vessels depends merely upon the movements of the body aided by the suction of the blood descending through the big veins in the root of the neck. For the maintenance of the flow in one direction, valves are therefore provided, as in the veins; and they are so closely set that a distended lymph vessel has a characteristic beaded appearance.

The lymph vessels that lie in the superficial fascia drain the lymph from the skin. For the most part, they run along the superficial veins and ultimately converge upon the important groups of lymph glands situated at the junction of the limbs and trunk. Only a few lymph glands are found in the superficial fascia, and they lie in its deeper part; nearly all glands are situated deeply, usually close to the deep veins, along which the deep lymph vessels also run.

The lymph vessels of the superficial fascia are like silken threads so slender that often they are not detected during the dissection. Indeed, it should be mentioned that, with the exception of the main, terminal lymph vessels and some of the larger afferents of the principal groups of glands, it is scarcely

possible to display the lymph vessels unless special methods of injection have been employed. Nevertheless, because of their great importance in the spread of disease, the dissector must make every endeavour to find the groups of lymph glands as he dissects each part, and to trace their afferent and efferent vessels as far as possible.

The lymph glands and vessels are of importance both in health and in disease. The lymph glands manufacture white blood-corpuscles, and they act as filters which entangle small particles that have found their way into the lymph stream. The varied colour of lymph glands is due to the foreign particles arrested in them; when the student dissects the thorax he will probably find that the lymph glands in the root of the lung are quite black owing to the dust and smoke inhaled into the lung, extracted by their lymph vessels and intercepted by the glands. The proper function of the lymph vessels is to collect the lymph and carry it (laden with some of the products of the tissues and with white corpuscles from the glands) to the blood stream.

But they can carry also the seeds of disease. Micro-organisms of disease that have invaded any part of the body may enter the lymph vessels, and that kind of bacteria and the poisons manufactured by them may be carried eventually to the blood and by it dispersed to all parts of the body. In the same way, the cells of malignant tumours (such as cancer) also may enter the lymph vessels, and either be carried *in* the lymph stream (denied by some on account of the size of the cells) or grow *along* the lymph vessels as a line of least resistance, and thus become the starting-point of a secondary malignant growth in some distant part. The lymph glands —interposed like small filtering sponges in the paths of the lymph vessels—may, however, intercept noxious materials (bacteria or tumour cells) that are passing along the vessels, and the cells of the gland may destroy them. Thus, though it is unfortunate that disease may be spread by lymph vessels, yet it is fortunate that the interruption of the vessels by the glands may cause an arrest of the process, or, at least, a delay in the spread, of which the surgeon may take advantage; and the lymphatic system is therefore, in a sense, a protective mechanism. But a gland may not be strong enough to destroy the bacteria, and the inflammation set up by them, instead of subsiding, may lead to an abscess; and the

tumour cells will probably, sooner or later, multiply and produce secondary malignant growths.

Since the glands are so often implicated, it is necessary, when a part is diseased, that the glands which receive its lymph should be examined for possible infection; on the other hand, enlarged or painful glands may be the first sign of disease in the parts whose lymph they receive. The student must learn, therefore, which glands drain the lymph from a given part (*i.e.* the "primary" glands for that part), and which parts are drained by a given group of glands.

The **nerves** are cords of a light grey colour or nearly white; they branch like arteries, and their branches often unite with one another. In a way, they resemble telegraph cables, because they are made of bundles of exceedingly fine filaments, called *nerve fibres*, bound together by fibrous tissue; and they carry messages, which are called *impulses*. The impulses are sent through them from the central nervous system (*i.e.* brain and spinal cord) to the various structures in the body, and from the structures to the central nervous system. The fibres that carry impulses from the central nervous system are called *efferent*, and those that carry impulses to it are *afferent*. The commonest outgoing impulses are those to muscles to make them shorten or contract to move some part of the body; and they are therefore called *motor*. The commonest incoming impulses are from the skin and other structures and convey information about sensations—touch, pain, heat, etc.—and are called *sensory*. The nerve connected with a muscle or with an area of skin is spoken of as "supplying" that muscle or that area.

The largest nerve in the body is the *sciatic nerve*, which lies in the buttock and in the back of the thigh, and is about half the thickness of the little finger. Most of the larger nerves in the limbs are of the thickness of a medium-size wax taper; and the others are of all sizes from that down to mere threads. In the superficial fascia, even the larger ones are fairly slender. At first, it may not be easy to distinguish a nerve from a small empty vein; but the vein can be easily stretched, while the nerve is firmer, and the nerve, being made of bundles of long fibres, is streaked lengthwise.

The nerves connected with the brain emerge from the skull or cranium, and are called *cranial nerves*. Those connected with the spinal cord are called *spinal nerves*; they have to

escape from the vertebral canal—*i.e.* the tunnel in the backbone that lodges the spinal cord. Nerves that supply a limb come from spinal nerves ; and in the early stages of dissection

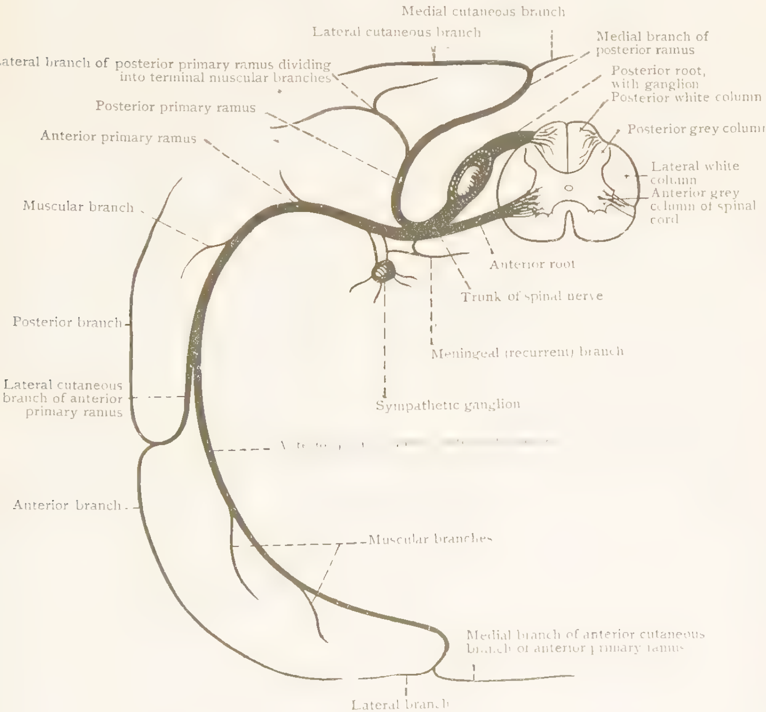


FIG. 1.—Diagram of a Typical Spinal Nerve. Note that the medial branch of the posterior primary ramus is represented as distributed to skin, whilst the lateral branch terminates at a deeper level in muscle. Both branches, however, supply muscles ; and in the lower half of the body it is the lateral branch that supplies skin.

reference has to be made to the names, numbers, and divisions of spinal nerves.

There are 31 pairs of **spinal nerves** — 8 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 1 coccygeal. They are named after the groups of vertebræ—*i.e.* the segments of the backbone or vertebral column. But note that there are 8 cervical nerves and only 7 cervical vertebræ, and that there is only

1 coccygeal nerve though there are 4 segments in the coccyx (which is the lowest part of the backbone).

Every spinal nerve is attached to the spinal cord by **two roots**—an anterior and a posterior (Fig. 1).

The **anterior root** consists of bundles of *motor* fibres.

The **posterior root** consists of bundles of *sensory* fibres. It is distinguished by the fact that it has a swelling on it, called the **spinal ganglion**, which is composed of microscopic *nerve cells*, mingled with nerve fibres.

The two roots unite, just beyond the ganglion, to form the *trunk* of the spinal nerve. The union takes place at the intervertebral foramen through which the nerve trunk leaves the vertebral canal.

The nerve **trunk** is very short. The roots unite merely in order that the motor and sensory fibres may be mixed together; and the nerve trunk, as it leaves the intervertebral foramen, splits into two divisions called the *anterior primary ramus* and the *posterior primary ramus*. (*Ramus* = a branch). Do not confuse the anterior and posterior roots with the anterior and posterior rami; nearly every primary ramus contains both motor and sensory fibres.

The **posterior primary ramus** is the smaller. It passes backwards into the mass of muscle on the back of the body. There, it divides into a *lateral branch* and a *medial branch*. Both those branches supply muscles, and one of them sends a branch to the skin. Dissectors of the limbs look for these *cutaneous* branches of posterior rami when they are dissecting the hip and buttock and the region behind the shoulder blade.

The **anterior primary ramus** runs in a lateral direction away from the vertebral column. The anterior rami of thoracic nerves run along the ribs; the upper eleven are *intercostal*, and the twelfth is *subcostal* (*costa* = a rib); they end as *anterior cutaneous* branches on the front of the trunk. In their course they give off a *lateral cutaneous* branch, which divides into anterior and posterior branches. The anterior rami of the other spinal nerves are more or less pleated together to form what are called *nerve plexuses*. Those of the cervical nerves (with part of the first thoracic) form two plexuses called the **cervical plexus** and the **brachial plexus.** Most of the nerves of the Upper Limb arise from the brachial plexus, and a few come from the cervical plexus. The brachial plexus lies in the neck and in the armpit; dissectors

of the Upper Limb combine with the dissectors of the Neck in displaying it. Those of the lumbar, sacral, and coccygeal nerves form plexuses that have the same names. Nearly all the nerves of the Lower Limb come from the **lumbar plexus** and the **sacral plexus.** These two plexuses lie near the backbone in the abdomen proper and pelvis; they will be dissected by the dissectors of the Abdomen.

The fibres of the anterior or motor root arise from nerve cells in the spinal cord. They run out into the anterior root, and onwards through the nerve trunk and primary rami into the various motor nerves. The fibres of the posterior or sensory root arise in the nerve cells of the spinal ganglion. Each sensory fibre, while still in the ganglion, splits into two branches—a central branch and a peripheral branch. Central branches run to the spinal cord, forming the sensory root of the nerve, and end around nerve cells in the spinal cord or in the lower part of the brain. Peripheral branches run outwards through the primary rami and onwards into the sensory nerves. A sensory impulse starts at the end of a peripheral branch, runs in it to the ganglion, and onwards in a central branch into the spinal cord.

Deep fascia is the name given to the bluish membrane that lies under cover of the superficial fascia. It is thin, but dense and strong; and the superficial fascia is loosely attached to it by fibrous strands. It clothes the muscles, investing them so closely that it forms a tight sheath around the limb and preserves the contours of the limb. From its deep surface it sends in wide sheets that form partitions or *septa* among the muscles. In that way the deep fascia provides fascial sheaths for many of the muscles, and for the vessels and nerves that lie among the muscles; and parts of some muscles are attached both to the investing fascia and to the septa. Some of the septa are attached to the bones and to the ligaments of joints that lie deeply among the muscles. The investing fascia is attached to the ligaments of joints and to the parts of bones that come to the surface between muscles; and in certain places it is thickened to form strong, restraining bands, called *retinacula*, that hold tendons or sinews in position, and serve also as pulleys on which the sinews move—for example, at the wrist and ankle.

The **muscles** are the red flesh of the body, and form nearly half of the weight of the body. They are the active agents

that produce movements, for they can be shortened or contracted at will to bring the parts to which they are attached closer together.

Each muscle has at least two attachments—one at each end. When the muscle contracts, it is usual for only one of those attachments to be moved. The attachment that usually remains fixed is called the **origin** of the muscle; the attachment that moves is its **insertion.** The limb muscles are attached mostly to bones and deep fascia, but some are attached also to cartilages and to the ligaments of joints.

The red, fleshy part of a muscle is called its **belly.** The belly is composed of bundles of red *muscle fibres* held together by white fibrous tissue. At the ends of a muscle the muscle fibres lose their red, fleshy character and become white fibrous tissue; and by these white fibrous ends they are attached to the bones, etc. In many muscles, especially at the origin, those terminal, white points are so short that the naked eye cannot see them; the muscle appears to be attached by red, fleshy fibres, and is, in fact, described as having a fleshy attachment. But many muscles terminate as long cords of white fibrous tissue by which they are attached. These cords have a greenish tinge, and are called **tendons** or sinews. Those on the back of the living hand are easily seen, for they raise the skin and fasciæ into ridges when the fingers are bent back. In some cases, especially when the muscle is thin and wide, the tendon is not a slender cord but is a thin, wide sheet called an **aponeurosis.** (*Neuron* and *nervus* originally meant *sinew*).

Numerous small arteries bring a rich supply of blood to nourish a muscle; and the blood is drained away by veins that lie alongside the arteries. Every muscle has at least one nerve of supply whose fibres convey motor impulses to it to make it contract or relax, and carry sensory impulses from it.

When a muscle or a tendon passes over a bone or a ligament or another tendon, a **bursa** is placed between them to lessen friction and make movement easier. A bursa is a closed bag or sac, made of white fibrous tissue, lined with a smooth membrane, called *synovial membrane*, which exudes an oily liquid, called *synovia*, into the interior of the bag to lubricate the surfaces. Normally the bag is almost empty, for the synovia is just enough to moisten the surfaces. For the same purpose, many tendons are enclosed in **synovial**

sheaths made of white fibrous tissue and lined with synovial membrane.

Ligaments are strong bands of white fibrous tissue that connect bony points. Most of them are found therefore at joints.

The **joints** of an adult limb are nearly all of the kind called **synovial joints.** The bones, where they touch or articulate with each other at a joint, are coated with the kind of gristle called *articular cartilage.* They are held together by a short, wide tube called the *capsule* of the joint. The capsule consists of an outer layer of strong white fibrous tissue called the *capsular ligament* and a lining of *synovial membrane*, which exudes *synovia* into the *joint cavity—i.e.* the space enclosed by the capsule. In many joints the capsular ligament is assisted in holding the bones together by additional ligaments and by extensions from the deep fascia, and is strengthened by thickenings of its own substance, which are named usually from their position, *e.g.*, medial ligament of the elbow.

Landmarks and Surface Anatomy. In a dissecting manual, it is assumed that the dissector has an elementary knowledge of the bones, which a student of the first year may have had no opportunity of acquiring before he seeks admission to the class of Practical Anatomy. Therefore, as soon as he is enrolled, he should procure a set of bones and a text-book containing a description of the bones, and learn the *chief* characters of the backbone, the breast bone, the ribs, and the bones of the part to which he has been assigned—omitting, in the meantime, the detailed description that includes the minor features and the attachments.

Some parts of the skeleton can be neither seen nor felt till the soft parts are removed. But the outlines of many of the bones and the projecting parts of others can be distinguished through the skin, for they make prominences on the surface. Many portions of bones that cannot be seen can, however, be felt quite easily when the finger is passed lightly over the places where they lie ; and others, that lie more deeply, may be felt if slight pressure is used. The student should identify these parts of the bones, on his own body or on one of his friends, as he reads the description of the bones ; and he should examine them again on the dead body before he begins dissection. He should do so until he is quite familiar with them both by sight and by touch, and can at once put his finger on

any given point, whatever the position of the body may be. This is necessary because these visible and palpable parts of bones are the landmarks by means of which the position of the soft parts can be defined both in the dead body and in the living, and also because the student must begin at once to train his eyes to see all that can be seen and his fingers to feel all that can be felt.

General Directions for Dissection.—Removal of the Skin.—The flaps of skin to be removed are marked out by cuts through the skin. *To make a Clean Incision*: Hold the blade at right angles to the skin, and drive the point through it till the superficial fascia is reached; you will know when you have reached the superficial fascia by the sudden diminution of the resistance. Then, incline the blade to an angle of 45° to the surface, and, pressing on the back of the blade with the forefinger, carry it steadily to the other end of the line of incision; and, lastly, bringing the blade to a right angle again, withdraw it.

To reflect a Flap of Skin.—Take hold of the most convenient angle with the forceps, and, with the edge of the scalpel, detach it from the superficial fascia. As soon as the angle is sufficiently detached, discard the forceps, grip the skin with thumb and forefinger, keep it tense, and, from one margin of the flap to the other, draw the edge of the knife across the skin at its junction with the superficial fascia—always keeping the edge against the skin. Do not take any fat away with the skin, else the small vessels and nerves that lie in the fat near the surface will be injured.

Dissection of the Superficial Fascia.—As soon as the skin is removed, the superficial fascia is dissected in order that the superficial vessels and nerves may be exposed and examined. The nerves and the arteries are all slender. They spring from the larger nerves and arteries that are more deeply placed. They pierce the deep fascia, and lie at first between the deep fascia and the superficial fascia; but they gradually pass through the superficial fascia to end in the skin. Each of the arteries is accompanied by a slender vein. Besides those small veins that accompany arteries, there are several larger veins that lie more superficially; but they also ultimately pierce the deep fascia to end in the more deeply placed veins.

At the outset of dissection the student must begin to

educate his fingers to recognise the different "feel" of the various structures. As the edge of the knife touches them—superficial and deep fascia, nerves, vessels, and muscles—they each provide a different sensation recognisable by the educated touch, which can be acquired only by attention and practice.

To remove the Superficial Fascia.—First, cut through it down to the deep fascia along a line in the uppermost part of the area or along the line given in the dissection instructions ; you will know when you have reached the deep fascia by the increased resistance that it offers to the knife. Next, raise the cut margin of the superficial fascia with the forceps or your fingers and draw it away, cutting the fibrous strands that attach it to the deep fascia, and keeping the edge of the knife directed towards the deep fascia, in order to remove the whole thickness of the superficial fascia. As you come upon the superficial nerves and vessels, disentangle them from the superficial fascia, clean the fat off their surfaces, and leave them lying on the deep fascia.

In tracing the nerves and their branches through the fat, use the knife with caution. Indeed, a great deal of dissection can be done with the forceps or a blunt dissecting hook, the knife being called into use to remove the superficial fascia from the spaces between the superficial structures after they have been isolated.

Deeper Dissections.—When you have removed all the superficial fascia from the area under dissection, and have studied the superficial structures, examine the characters and connexions of the deep fascia, and then remove it in order to expose the muscles and other deep structures. The deep fascia not only clothes the muscles but also gives attachment to many of them ; the cleaning of a muscle—that is, the removal of the fascia from it—is therefore not always easy.

To clean a Muscle.—Put the muscle on the stretch by moving the limb. Define the margins of the muscle. Cut boldly through the deep fascia until the red bundles of the muscle are exposed. Seize the cut edge of the fascia, and put slight traction upon it. Keep the edge of the knife playing against the muscle to ensure the entire removal of the fascia. Carry the blade in the direction of the muscular bundles, changing direction as the course of the bundles alters.

The cleaning of the deeper muscles and of the deep surfaces of the more superficial muscles requires the removal of fat as

well as of fascia. Take care throughout not to injure the nerves of supply. The nerves in the greatest danger are those that supply the more superficial muscles, for almost all of them enter the muscles through their deep surfaces.

Do not be content with cleaning the main part of a muscle and leaving its ends untouched. Define and clean the ends of each muscle ; otherwise you cannot verify its attachments ; and, unless you actually see the attachments, you put an unfair burden on your memory when you try to learn its origin and insertion.

To clean the Deeper Vessels and Nerves.—This means merely the piecemeal removal of the fat and loose fibrous tissue in which they are embedded. Begin with the main trunks. Clean them ; trace their branches, and clean them also. This work is often very tedious ; and the dissector often finds that he is hampered (especially in the thigh) by the veins and by the branches of arteries that supply muscles. Keep the main venous trunks and most of the arteries. Have no hesitation in removing the veins that accompany the smaller arteries, or in dividing the smaller arteries that supply muscles, if they are in the way. When you review the dissection afterwards, you will remember that wherever arteries are, there were veins also ; the divided arteries, though cut, are still present, and they are often too variable to require much study. But be careful of nerves. They are much more constant in position than arteries. Trace all of them to their destinations and leave them uninjured.

The dissector will now proceed to the study of the Limb which has been allotted to him. The dissection of the Lower Limb begins on p. 206.

PLATE I

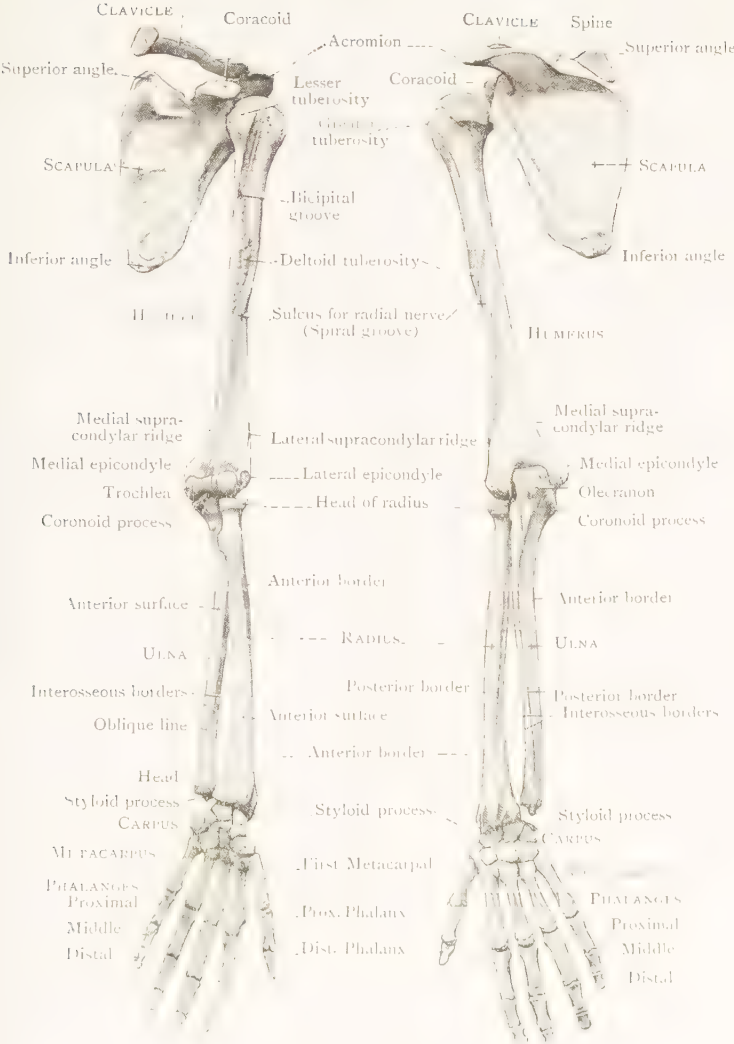


FIG. 2. Bones of Left Upper Limb.

Anterior view. Posterior view.

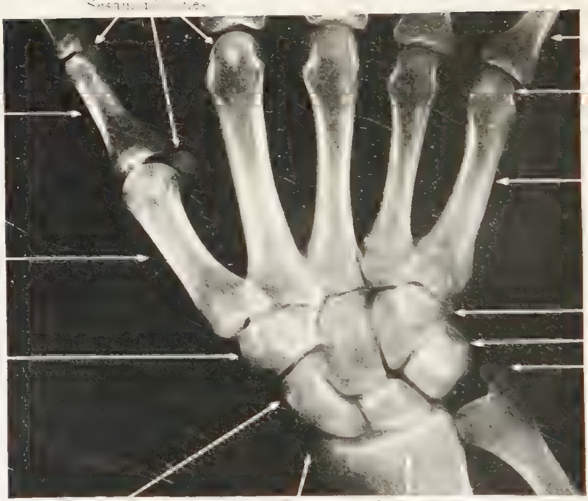


FIG. 3A.—Radiograph of Wrist and Palm of girl aged 17
(Dr. J. Duncan White.)

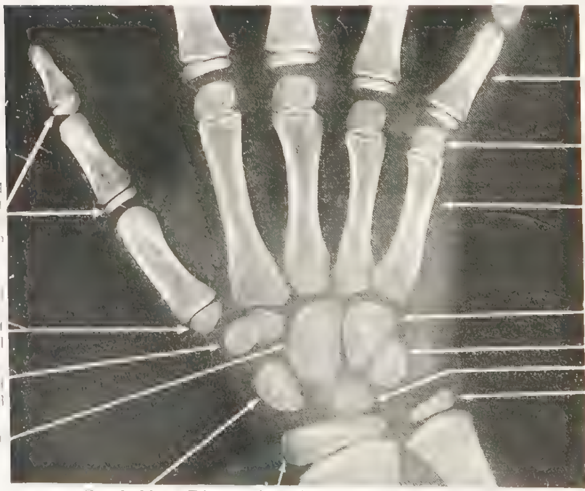


FIG. 3B.—Radiograph of Wrist and Palm of girl aged 7
(Dr. J. Duncan White.)

UPPER LIMB

Introduction. The parts of the Upper Limb are the *shoulder*, the *upper arm* or brachium, the *forearm* or antebrachium, and the *hand* or manus.

The region of the **shoulder** includes more than the familiar prominence at the upper end of the arm. It includes also: (1) The **axilla** or armpit; (2) the **scapular region** or the parts around the shoulder blade; and (3) the **pectoral region** on the front of the chest. (*Pectus* = the front of the chest). The bones of the shoulder form the *shoulder girdle*. They are the **scapula** or shoulder blade and the **clavicle** or collar bone (Figs. 2, 24, 35). They articulate with each other at the top of the shoulder to form a joint called the **acromio-clavicular joint**; and the clavicle articulates with the upper end of the sternum or breast bone to form the **sterno-clavicular joint.**

The **upper arm** is the part between the shoulder and the *elbow* or cubitus. Its bone is called the **humerus,** which articulates with the scapula to form the **shoulder joint.**

The **forearm** extends from the elbow to the wrist. It has two bones—the **radius** and the **ulna.** They articulate with the humerus to form the **elbow joint**; and they articulate with each other, at their upper and lower ends, to form the **superior** and **inferior radio-ulnar joints.** When the limb is held so that the palm of the hand looks forwards, the two bones are parallel—the radius on the lateral side of the ulna. When the limb is rotated so that the palm looks backwards, the radius lies obliquely across the front of the ulna.

The **hand** is subdivided into: (1) The *wrist* or carpus, (2) the *hand proper* or metacarpus, and (3) the digits (*thumb* and *fingers*).

The skeleton of the **wrist** is a group of eight little bones called **carpal bones,** arranged in two rows—an upper and a lower (Figs. 2, 3, 70). They articulate with one another to

form **intercarpal joints**; and the upper row articulates with the radius to form the **radio-carpal** or **wrist joint.** On the back, they are under cover of the tendons below the lower ends of the radius and ulna; on the front, they are to a large extent obscured by the ball of the thumb and the ball of the little finger.[1]

The **hand proper** has a skeleton of five bones called **metacarpal** bones. They correspond to the five digits, and are numbered 1 to 5, beginning with the one above the thumb. At their upper ends or bases, they articulate with one another, forming **intermetacarpal joints,** and with the lower row of carpal bones, forming **carpo-metacarpal joints.**

The **digits** are named: *Thumb* or pollex; *forefinger* or index; *middle finger* or digitus medius; *ring finger* or annularis; and *little finger* or minimus. The bones of the digits are called **phalanges.** The thumb has two phalanges; the other digits have three. The proximal phalanx articulates with the lower end or head of a metacarpal bone to form a **metacarpo-phalangeal joint.** The second one articulates with the other two to form **interphalangeal joints.** On the front of some of the metacarpo-phalangeal joints there are, occasionally, little nodules of bone called **sesamoid bones** (Fig. 3).

PECTORAL REGION AND AXILLA

The dissector of the Upper Limb will begin practical work on the fourth day after the subject has been placed in the dissecting-room. He will find the body lying on its back. The thorax has been raised to a convenient height by means of blocks, and a long board has been placed under the shoulders for the purpose of supporting the upper limbs when they are abducted from the sides.

Until the dissection of the axilla is completed the dissectors of the Upper Limb and of the Head and Neck will find it advantageous to arrange to work at different hours. The dissector of the Head and Neck, at this stage, is engaged on the posterior triangle of the neck, and the dissection of the triangle cannot be well done unless the limb is placed close to the

[1] The *wrist* of anatomical descriptions is not the same as the "wrist" of every-day speech. The "wrist" in ordinary conversation is really the distal part of the forearm. The anatomical *wrist* is distal to the best marked of the creases at the lower end of the front of the forearm, and, on the surface, is not marked off from the rest of the hand.

side and the shoulder depressed. For the dissection of the axilla, the limb should be stretched out at right angles to the thorax. A compromise between these two positions always results in discomfort to both dissectors.

Five days are allowed for the examination of the pectoral region and axilla beginning with the surface anatomy. The following table will be found useful in regulating the amount of work which should be carried out on each day :—

First Day.—(*a*) Surface anatomy; (*b*) reflexion of the skin; (*c*) cutaneous vessels and nerves of the front of the thorax; (*d*) examination of the fascia of the pectoralis major and the axillary fascia; (*e*) cleaning of the pectoralis major; (*f*) reflexion of the pectoralis major.

Second Day.—(*a*) Examination of the clavi-pectoral fascia and the structures piercing it; (*b*) removal of the clavi-pectoral fascia and examination of the structures behind it.

Third Day.—(*a*) Cleaning of the pectoralis minor; (*b*) cleaning of the contents of the axilla below the level of the pectoralis minor.

Fourth Day.—(*a*) Reflexion of the pectoralis minor; (*b*) completion of the cleaning of the contents of the axilla; (*c*) cleaning of the serratus anterior; (*d*) cleaning of the posterior wall of the axilla; (*e*) reflexion of the subclavius; (*f*) examination of the sterno-clavicular joint and disarticulation of the clavicle at that joint.

Fifth Day.—(*a*) Examination of the brachial plexus and a general review of the axilla and its contents.

Surface Anatomy.—The **clavicle** lies between the neck and the front of the chest, and can be both felt and seen. It extends from the top of the shoulder to the upper end of the **sternum.** Draw your finger along it from one end to the other. Note that, in its medial two-thirds, it is curved with its convexity forwards, to give room for the passage of vessels and nerves between the neck and the axilla. The medial end of the clavicle (Fig. 4) articulates with the sternum, and also overrides the top of the sternum, and therefore produces a prominence that is easily felt. The prominence is, however, slightly masked by a part of the **sterno-mastoid muscle**—that is the muscle which extends from the sternum and the clavicle to the skull behind the ear and rises as a strong, blunt ridge on the living neck when the face is turned towards the other side.

Place the tip of the index finger in the notch at the upper end of the sternum between the clavicles, and draw it downwards along the median line. About two inches below the upper end of the sternum, a blunt, transverse ridge is distinctly felt. That ridge marks the union of the *manubrium* (or first piece of sternum) with the body of the sternum. It is the

best landmark on the front of the chest, for it can be felt even in stout people, and in many people it can be seen. The **cartilage of the second rib** joins the side of the sternum at that ridge. The second rib is therefore more easily identified than any other. To find one of the other ribs, locate the second, and count downwards from it. The anterior part of the **first rib** is about an inch above the second, and is masked by the clavicle. Continue to draw the finger down over the sternum. At the lower end of the body of the sternum the finger sinks into a shallow depression. That is the **epigastric fossa** or "pit of the stomach." The bony, but slightly yielding, structure felt on the floor of the fossa is the third or lowest piece of the sternum, and is called its **xiphoid process.** The upper boundary of the epigastric fossa is a short transverse ridge that marks the junction of the xiphoid process with the body of the sternum; the right and left boundaries are the **cartilages of the seventh pair of ribs.**

The **nipple** is rather variable in position, even in the male; but usually it is opposite the space between the **fourth** and **fifth ribs**, and is a guide to their position; it is near their junction with their cartilages. Measure its distance from the median plane; it is usually about four inches.[1]

Come back to the clavicle. With the eye, divide it into thirds. Below the junction of the lateral and intermediate thirds, there is a depression called the **infraclavicular fossa.** The soft bulging at the medial side of the fossa is part of a large muscle, called **pectoralis major**, that lies on the front of the chest and in the anterior wall of the axilla. The prominence on the lateral side is the anterior part of the **deltoid muscle**, which lies on the side and the back and the front of the shoulder. Put your finger in the infraclavicular fossa an inch below the clavicle, and press it sideways under the deltoid. The bone felt there is the **coracoid process** of the scapula, and though felt only indistinctly, it is frequently referred to as a landmark (Figs. 2, 15, 50).

The lateral end of the clavicle articulates with the medial margin of the acromion of the scapula. The **acromion** is a flattened piece of bone about an inch wide that lies in the top of the shoulder. (*Acron* = summit; *omos* = shoulder). The upper surfaces of acromion and clavicle lie in nearly the same

[1] Your own hand is a rough measure. A man's hand is about four inches across, and his thumb print about one inch.

plane; therefore, the **acromio-clavicular joint** is inconspicuous; but it can be detected easily if the limb is moved.

Abduct the arm. That is, draw it in a lateral direction from the trunk. The hollow of the **axilla** and the two rounded folds that bound it in front and behind are brought into view. The **anterior fold** encloses part of the **pectoralis major** muscle and part of the **pectoralis minor**, which underlies the major. The **posterior fold** encloses two muscles, called teres major and latissimus dorsi. The **teres major**—a stout, round muscle—extends from the lower angle of the scapula to the upper part of the shaft of the humerus. The **latissimus dorsi**—wide and thin—lies in the lower part of the back, but narrows to form a flattened tendon, which, as it approaches the humerus, winds round the teres major. Draw the arm well from the side. The edge of the latissimus dorsi then raises up a distinct ridge of skin that runs downwards and backwards; the lowest rib that the ridge crosses is the **eleventh rib.** Grip the posterior fold between finger and thumb: the different consistence of the fleshy teres and the tendinous latissimus can be distinguished through the skin and fasciæ. Note that the posterior fold reaches lower down than the anterior fold does, and that therefore the structures in the lowest part of the axilla have no muscle in front of them.

Place the fingers in the **axilla** and examine its walls. The **anterior wall** is soft and fleshy. So is the **posterior wall**; but the lateral margin of the **scapula** can be felt in it. The **ribs** are felt in the medial wall—covered with a wide muscle called **serratus anterior.** The lateral wall is narrow. The softer parts felt in it are two muscles called the **biceps brachii** and the **coraco-brachialis**; the hard part is the neck of the **humerus** and the upper part of its shaft; if the thumb is moved backwards and forwards over the humerus, some of the large nerves of the axilla can be felt between the thumb and the bone; and in the living limb the **axillary artery** can be felt beating. Push the fingers well up into the axilla and rotate the arm: the globular **head of the humerus** can be felt indistinctly.

Dissection.—Reflexion of the Skin.—Incisions (Fig. 4):—(1) Along the median line of the body from the upper margin of the manubrium sterni to the tip of the xiphoid process. (2) Upwards and laterally from the tip of the xiphoid process to the nipple. At the nipple the incision must bifurcate to encircle the dark patch of skin around the nipple; it must then be continued

along the anterior fold of the axilla to the arm. As soon as it reaches the arm it must be carried downwards for two and a half

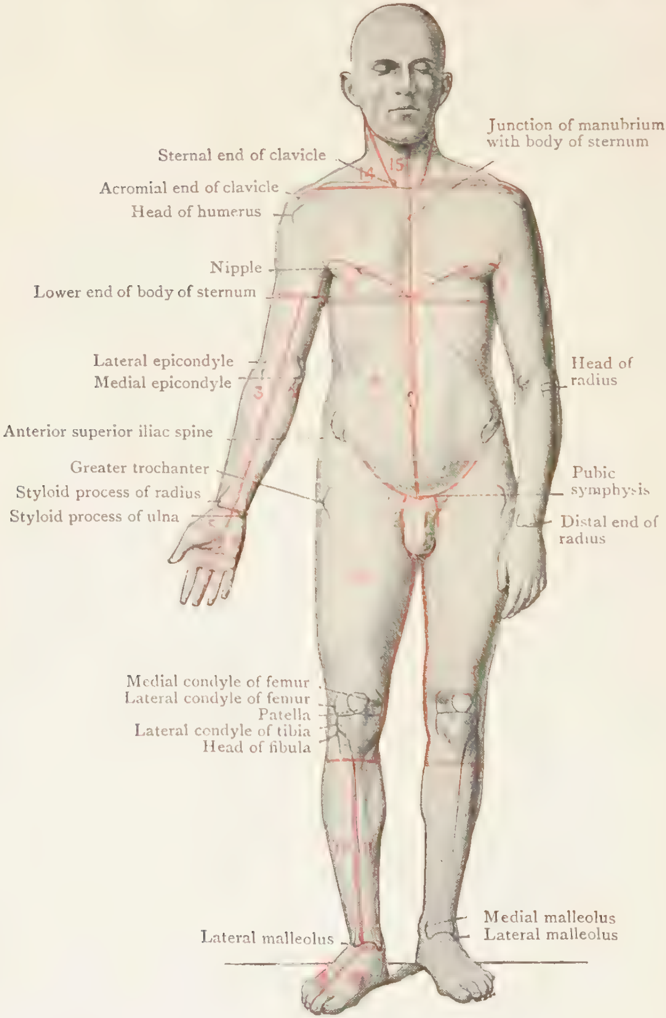


FIG. 4.—Landmarks and Incisions.

or three inches, and then transversely to the lateral border of the arm. (3) From the tip of the xiphoid process transversely across

the front and side of the chest to the plane of the posterior fold of the axilla.

Reflect the flaps of skin thus marked out (1 and 2, Fig. 4), beginning in the median plane at one of the angles. Do not detach the flaps wholly. Leave them hanging by their lateral ends, in order that they may be replaced when dissection for the day is finished. Leave the small patch around the nipple.

As the reflexion proceeds, note that the connexion between the superficial fascia and the skin is stronger in some places than in others. In the female, definite fibrous strands will be found passing from the mammary gland to the skin.

When the reflexion of the flaps is completed the superficial fascia is exposed.

Superficial Fascia.—In this region the fat of the superficial fascia is not usually very plentiful except in female bodies, where it is abundant in the region of the mammary gland. Near the clavicle a reddish striation is usually visible through the fat; it is due to the lower part of a thin muscle of the neck, called the *platysma*, which extends down over the clavicle into the upper part of the front of the chest.

Cutaneous Nerves and Vessels. After the general characters of the superficial fascia have been noted, the nerves and vessels which pass through it to the skin must be sought for. They are :—

Supraclavicular nerves, from the cervical plexus.

Anterior cutaneous branches } from intercostal nerves (*i.e.* from anterior primary rami of thoracic nerves).
Lateral cutaneous branches }

Cutaneous arteries derived from various deep arteries. Cutaneous veins.

The cutaneous arteries are so small that the red injection seldom runs into them.

Dissection.—Cut through the superficial fascia along the margin of the sternum. Lift its cut edges, and find the *anterior cutaneous nerves* as they pierce the deep fascia at the sternal ends of the intercostal spaces. They are very slender, but their greyish, streaked appearance distinguishes them from surrounding tissues, and the accompanying arteries, if injected, are guides to them. Trace their branches medially and laterally as far as possible.

Next, cut through the superficial fascia and the platysma along the upper border of the clavicle from the sternum to the shoulder, and turn them downwards. Look for the *supraclavicular nerves*. They are slender nerves that stream downwards across the clavicle. Trace them downwards through the platysma into the superficial fascia of the shoulder and the front of the chest.

Thirdly, beginning at the arm, cut through the superficial fascia along the anterior fold of the axilla and continue the cut downwards and in a medial direction for three or four inches. Reflect the cut edges of the fascia, and look for the *anterior*

branches of the lateral cutaneous nerves as they pierce the deep fascia at the lower border of the pectoralis major. Trace them medially through the superficial fascia.

The **supraclavicular nerves** arise in the neck from the third and fourth cervical nerves. They spread out as they descend, pierce the deep fascia of the neck, cross the clavicle under cover of the platysma, and run downwards to supply the skin that overlies the deltoid and pectoralis major muscles as far down as the level of a horizontal line drawn from the

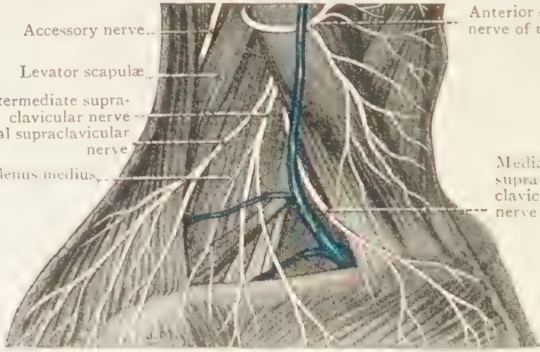


FIG. 5.—The Supraclavicular Branches of the Cervical Plexus.

second costal cartilage. They are accompanied by small vessels. They are named, according to their positions, the medial, the intermediate, and the lateral supraclavicular nerves (Fig. 5). The *medial*—one or more—are the smallest of the series; they cross the medial part of the clavicle. The *intermediate branches*—two or three—pass over the middle of the clavicle. The *lateral*—one or more—cross the lateral third of the clavicle, and will be followed to the skin of the shoulder afterwards.

The **anterior cutaneous nerves** are the minute terminal twigs of the intercostal nerves. They emerge from the intercostal spaces, and pierce the pectoralis major muscle and the deep fascia close to the sternum. One will be found in each intercostal interval except, occasionally, the first; they give slender twigs to the skin over the sternum, and larger branches which run laterally and may be traced as far as the anterior fold of the axilla.

The small arteries that accompany those nerves are the

perforating branches of an artery, called the *internal mammary*, which lies in the thorax immediately behind the costal cartilages. The perforating arteries of the second, third, and fourth spaces are fairly large in the female (especially the third), for they send branches to the mammary gland.

The **lateral cutaneous nerves,** much larger than the anterior, arise from the intercostal nerves, and appear, on the

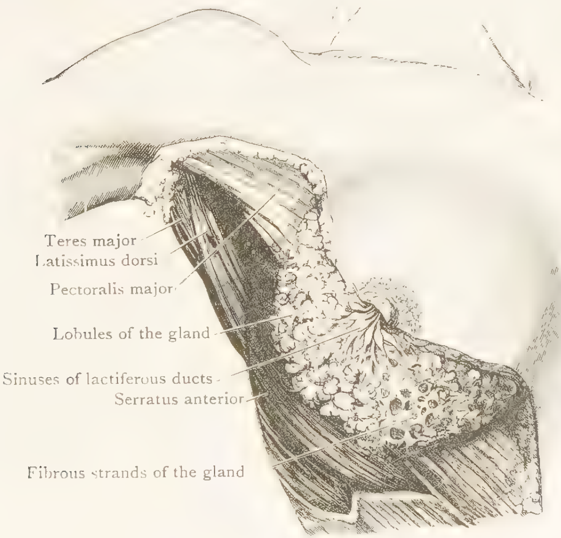


FIG. 6.—Dissection of the Mammary Gland.

side of the thorax, along a line situated a little behind the anterior fold of the axilla; they will be examined when the axilla is dissected.

The dissectors will now study the mammary gland—taking note of its position and connexions before beginning its dissection.

The Breast.—The mamma or breast is made up of (1) the mammary gland, (2) the superficial fascia in which the gland is embedded, and (3) the overlying skin, including the nipple and the areola around the nipple.

In the male, the mammary gland is quite rudimentary. The nipple is small and pointed, and the areola is surrounded by sparse hairs, which are never present in the female.

In the female, the **mammary gland** is situated on the front of the thorax and also, to some extent, on the side. It lies *in* the superficial fascia, and its smooth contour is largely due to the invasion of its substance by the fatty tissue of that fascia.

A little below its mid-point, and at a level which usually corresponds to the fourth intercostal space, the breast is surmounted by the *nipple*, which is placed in the middle of a circular patch of coloured skin known as the *areola of the breast*. There is no fat under the areola or in the nipple. A curious change of colour occurs in this region in the female during the second month of pregnancy. At that time the delicate pink colour of the skin of the nipple and areola becomes converted to brown by the deposition of pigment; and it never again resumes its original appearance.

FIG. 7.—Section through a Mammary Gland prepared by the method recommended by Sir Harold Stiles.

The mammary gland extends from the side of the sternum almost to the mid-axillary line, and from the second rib to the sixth costal cartilage. About two thirds of the gland is placed on the pectoralis major muscle, whilst the remaining part—its infero-lateral third—extends beyond the anterior fold of the axilla, and lies on the serratus anterior muscle. From the part related to the lower border of the pectoralis major a prolongation extends upwards into the axilla, and reaches as high as the third rib.

The mammary gland has no capsule, and is not enclosed in a fascial sheath ; in those respects it differs from many other glands. Its lobules and lobes are embedded in the superficial fascia between strands of fibrous tissue which pass through the superficial fascia from the skin to the deep fascia. The strands form the stroma or framework of the gland ; and the mammary blood vessels and lymph vessels which pierce the pectoralis major enter and leave the gland along these strands. They support and bind together the various parts of the true glandular tissue, which consists of tubes lined with cells ; and they attach the gland both to the skin and to the deep fascia.

The main body of the gland is composed of gland tissue and stroma compactly arranged to form a wide-based conical mass ; but many processes of stroma and gland substance project from the surface and borders of the central mass ; and the fat deposited in the hollows between the projections gives the breast its smooth and rounded contours.

The gland tubes secrete the milk, and are grouped together into distinct *lobes*—fifteen to twenty in number—each subdivided into *lobules*, and all separated from one another by the fibrous stroma. The *lactiferous ducts*, one from each lobe, converge upon the nipple. Under the areola, each duct expands to form a *lactiferous sinus*, and, narrowing again, opens independently on the summit of the nipple (Figs. 6, 7).

In a well-injected subject, twigs from the *intercostal arteries* and also from the *perforating branches* of the *internal mammary artery* may be traced into the mammary gland ; and *mammary branches* of the *lateral thoracic artery* may be seen winding round the edge of the pectoralis major, or piercing its lower fibres, to reach the gland.

Lymph vessels of mammary gland.—It is convenient to deal with the lymph drainage of the mammary gland here, although the dissector is not yet in a position to understand the details. It is necessary that he should understand it, for the arrangement of the lymph vessels of the mamma and the widespread situations of its primary lymph glands are of the greatest importance in the spread of malignant growths of the breast, in determining the extent of tissue to be removed by the surgeon and in foretelling the prospect of arresting the disease. The student should therefore refer back to the

description given here after he has dissected the axilla, where most of the glands are situated.

The main lymph vessels of the mammary gland converge, along the lines of the ducts, upon a close network beneath the areola. Lymph vessels issue from that plexus, and also directly from the margins and deep surface of the gland, and connect it with numerous lymph glands in its neighbourhood. The principal lymph glands to which they go are the upper

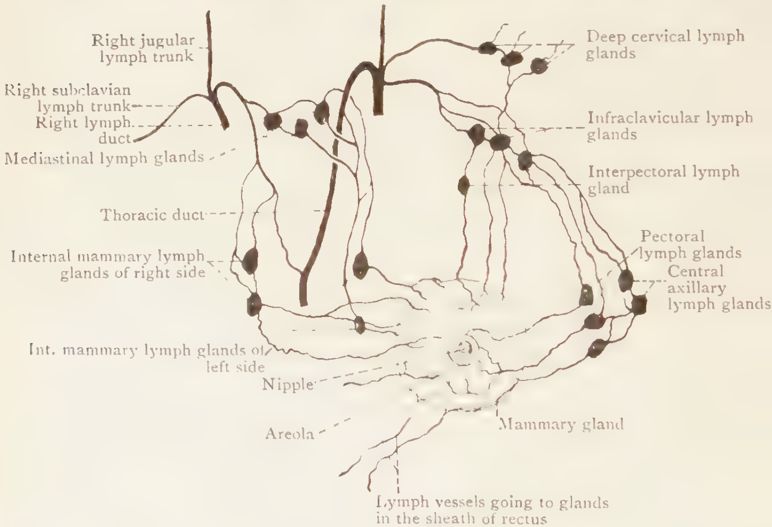


FIG. 8.—Diagram of the Connexions of the Lymph Vessels of the Left Breast.

members of the pectoral group of axillary glands: two main vessels proceed to them from the subareolar plexus (Figs. 8, 13). Other primary lymph glands for the peripheral parts of the mamma are the infraclavicular glands, those between the pectoral muscles, those alongside the internal mammary vessels of the same side or both sides, and glands in the upper part of the sheath of the rectus abdominus—(*i.e.* a muscle that lies along the median line of the front of the abdomen). (Figs. 8, 13).

Dissection.—If the subject is a female, endeavour to make out some of the details described. Remove the fat from the surface of the gland, and define some of its lobes. Reflect the

skin of the areola towards the nipple ; if possible, pass a bristle into one of the ducts through its orifice on the nipple, and trace it to a lobe.

Next, gradually detach the gland from the deep fascia. Begin at the upper border, and, as the gland is displaced, note the strands of the stroma which connect its deep surface with the deep fascia. Trace the process that extends from the lateral margin of the gland into the axilla.

Finally, remove the gland by cutting the vessels at its margins ; and then examine the deep fascia.

Deep Fascia.—The pectoral fascia is a thin membrane which closely invests the pectoralis major. It is attached above to the clavicle, and medially to the front of the sternum. Below, it is continuous with the deep fascia covering the abdominal muscles ; and, at the lower border of the pectoralis major muscle, it is continuous with the axillary fascia. Laterally, it is continuous with the fascia that covers the deltoid muscle. At the infraclavicular fossa, a process from its deep surface dips in, between the deltoid and pectoralis major muscles, to join the clavi-pectoral fascia (costo-coracoid membrane), which is a fascial membrane that lies behind the upper part of the pectoralis major, and will be described later (p. 34).

The **axillary fascia** is a dense, felted membrane which extends across the base of the axilla. It is continuous anteriorly with the pectoral fascia, posteriorly with the fascial sheaths of the latissimus dorsi and teres major muscles, medially with the deep fascia on the surface of the serratus anterior, whilst laterally it is continuous with the deep fascia on the medial surface of the arm. It is drawn up towards the hollow of the axilla, and the elevation is due chiefly to the connexion of its deep surface with the fascial sheath of the pectoralis minor, and partly to its attachment to the areolar tissue in the axilla.

Dissection.—Cut through the deep fascia along the groove between the pectoralis major and the deltoid, and display the *cephalic vein* (Figs. 28, 32) and the artery that accompanies it. Follow them upwards to the infraclavicular fossa, where they disappear under cover of the pectoralis major. As you clean the vein, look for the small *delto-pectoral lymph glands* that sometimes lie alongside it.

Next, clean the anterior part of the deltoid and the whole of the pectoralis major muscle.

Begin at the anterior border of the deltoid, and reflect the fascia until the base of the skin flap is reached. As the fascia is reflected, look for small cutaneous nerves : (1) *lateral supraclavicular nerves* over the upper part of the deltoid ; (2) near the

base of the skin flap, filaments of the *upper lateral cutaneous nerve of the arm* ; (3) other cutaneous twigs that pierce the anterior part of the deltoid (Figs. 28, 29, 32).

To clean the pectoralis major : make the muscle tense by abducting the arm ; begin at one or other border, and reflect the fascia upwards or downwards.

Delto-pectoral lymph glands.—These glands—one or two—lie in the groove between the deltoid and the pectoralis major. They are placed in the path of the superficial lymph vessels that run along the cephalic vein and convey lymph from the lateral side of the upper arm and shoulder and of part of the forearm, and transmit the lymph to the infra clavicular glands which lie in the apex of the axilla behind the clavi-pectoral fascia (Figs. 13, 30).

Pectoralis Major. The pectoralis major is a powerful muscle that extends from the front of the thorax to the humerus. It is divided by a deep fissure into clavicular and sterno-costal portions. The fissure penetrates through the entire thickness of the muscle - the two portions being distinct, except close to their insertions. The *clavicular portion* arises from the medial half of the front of the clavicle. The *sterno-costal portion* takes origin (1) from the anterior surface of the sternum, (2) from the upper six costal cartilages, and (3) from the aponeurosis of the external oblique muscle of the abdomen.

The muscle is inserted, by a flattened, bilaminar tendon, into the lateral lip of the bicipital groove of the humerus.

The arrangement of the tendon and the muscle fibres is peculiar. The tendon is folded on itself to form two laminæ, united along their lower borders and wholly blended together near the insertion. The muscle fibres undergo re arrangement as they approach the tendon. The upper sterno-costal fibres converge upon the anterior lamina. This lamina is joined also by the clavicular head, whose lower or medial fibres form the lower border of the lamina, which mixes with the insertion of the deltoid and sends an expansion into the adjoining deep fascia. The lower part of the muscle forms the posterior lamina, the lowest fibres curving upwards to form its upper border, which sends an expansion to the capsule of the shoulder joint. The downward slant of the clavicular head and the upward curve of the lowest fibres give a concave, rounded contour to the lower border of the muscle, and. consequently, to the anterior fold of the axilla.

The pectoralis major is supplied by the *medial* and *lateral pectoral nerves*. It is an adductor and a medial rotator of the upper limb ; when the limb is flexed—*i.e.* thrust forwards—the pectoralis major assists in pulling it back again, and after the limb is extended, the muscle takes part in drawing it forwards.

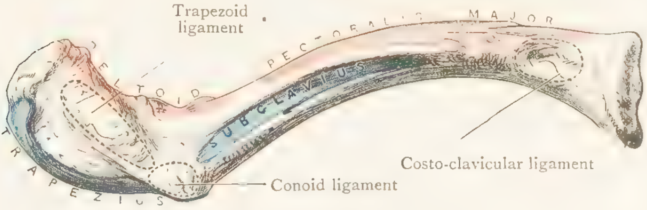


FIG. 9.—Lower Surface of the Right Clavicle.

AXILLA

The axilla is the hollow between the upper part of the side of the thorax and the upper part of the arm. When the arm is abducted from the trunk, and the areolo-fatty tissue which occupies the axilla is removed, the space disclosed has the form of a four-sided pyramid. The apex lies at the medial side of the coracoid process, and is directed upwards towards the root of the neck, whilst the base of the space looks downwards. The medial wall, formed by the thorax, is of greater extent than the lateral wall, which is formed by the arm ; the anterior and posterior walls, therefore, converge as they approach the lateral wall. The posterior wall is longer, from above downwards, than the anterior wall, and the posterior border of the base is therefore lower than the anterior.

Before beginning the dissection of the space, examine its boundaries and the manner in which the contents are disposed in relation to the boundaries.

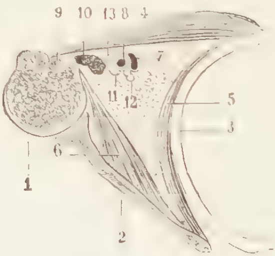
Boundaries and Contents of the Axilla. The four walls of the axilla are anterior, posterior, medial, and lateral.

The *anterior wall* consists of (1) the two pectoral muscles, (2) the subclavius, and (3) the fascia which surrounds the pectoralis minor and attaches its upper border to the clavicle, and its lower border to the floor of the axilla and to the deep

fascia of the arm. The pectoralis major forms the superficial stratum, and is spread out over the entire extent of the anterior wall. The pectoralis minor lies behind the pectoralis major, and forms part of the middle third of the anterior boundary. The fascia which fills the gap between the pectoralis minor and the clavicle is called the *clavi pectoral fascia* ; it splits above to enclose the subclavius muscle, and along the lower border of that muscle it is stronger than elsewhere. The lower border of the anterior wall is the *anterior fold* of the axilla. It is formed by the lower border of the pectoralis major, strengthened, medially, by the lower border of the pectoralis minor, which extends downwards a little beyond the major near the side of the thorax.

The *posterior wall* of the axilla consists of (1) the lateral

1. Proximal end of humerus.
2. Scapula.
3. Rib.
4. Pectoralis major.
5. Serratus anterior.
6. Subscapularis.
7. Axillary vein.



8. Axillary artery.
9. Long head of biceps.
10. Conjoined origin of short head of biceps and coraco-brachialis.
11, 12, 13. Brachial nerves.

FIG. 10.—Diagram of section through the Axilla of the Left Side.

part of the subscapularis muscle, (2) a portion of the latissimus dorsi and its tendon, and (3) the teres major muscle. The subscapularis covers the costal surface of the scapula. The latissimus dorsi winds from the back, round the medial part of the lower border of the teres major to gain its anterior surface ; thus, the lower border of the posterior wall—that is the *posterior fold* of the axilla—is formed in its medial part by the latissimus dorsi, and laterally by the lower margin of the teres major.

In the *medial wall* there are parts of the upper five ribs with the intervening intercostal muscles ; they are covered by the corresponding digitations of the serratus anterior muscle.

The *lateral wall* is formed by the humerus and the conjoined upper parts of the coraco-brachialis muscle and the short head of the biceps muscle.

The *apex* of the space leads up into the narrow, triangular interval, called the *cervico-axillary canal*, through which the axilla communicates with the neck. The canal is bounded anteriorly by the clavicle, medially by the outer border of the first rib, and posteriorly by the upper margin of the scapula; through it pass the axillary vessels and the big nerve cords of the brachial plexus on their way from the neck to the arm.

The wide *base* or floor of the axilla is closed by the vaulted axillary fascia.

The most important *contents* are the axillary artery and vein, the large nerves of the upper limb, and the axillary lymph vessels and lymph glands. They are all embedded in soft fat. Except at the apex, the great vessels and nerves lie close to the lateral wall, and follow it in all the movements of the arm.

Dissection.—Cut through the clavicular fibres of the pectoralis major, immediately below the clavicle. Scrape the fibres away from their attachment to the clavicle and note the extent of that attachment. Then, turn the clavicular head towards the insertion, and, as you do so, secure the branches of the *lateral pectoral nerve*, which pass into the deep surface of the muscle; trace them back to the *clavi-pectoral fascia*, which lies behind the clavicular head of the pectoralis major. Follow the *cephalic vein* to the point where it pierces that fascia. Clean the small arteries in this region; they are branches of the *acromio-thoracic artery*, which also pierces the fascia. Clean the clavi-pectoral fascia and the fascia on the part of the pectoralis minor that has been exposed. Turn now to the sterno-costal part of the pectoralis major, and cut through it about two inches from the sternum. Turn the medial part towards the median plane, and examine its attachments. Reflect the lateral part of the muscle towards the arm; whilst doing that, secure the *medial pectoral nerve*, which perforates the pectoralis minor and ends in the pectoralis major. Clean the fascia that covers the remainder of the pectoralis minor. Reflect the pectoralis major fully; clean its tendon, and examine its insertion (p. 30).

When the pectoralis major is completely reflected, a thick, continuous sheet of fascia is exposed, which extends from the clavicle to the axillary fascia, and from the wall of the thorax to the arm. It is because of the attachment of that fascial sheet to the clavicle superiorly and to the axillary fascia inferiorly that the floor of the axilla is raised as the arm is abducted from the side and the clavicle is elevated. The pectoralis minor muscle, passing obliquely from its origin on the thoracic wall to its insertion into the coracoid process of the scapula, runs through the substance of the sheet and

divides it into three parts: (1) The middle part encloses the muscle. (2) The lower part, as it extends downwards to blend with the axillary fascia, covers the lower parts of the axillary vessels and nerves. (3) The upper part is the clavi-pectoral fascia.

The **clavi-pectoral fascia** (costo-coracoid membrane) occupies the gap between the clavicle and the pectoralis minor, and extends from the first rib medially to the coracoid process laterally. Its upper part is split into two layers, an anterior and a posterior, which are attached to the clavicle,

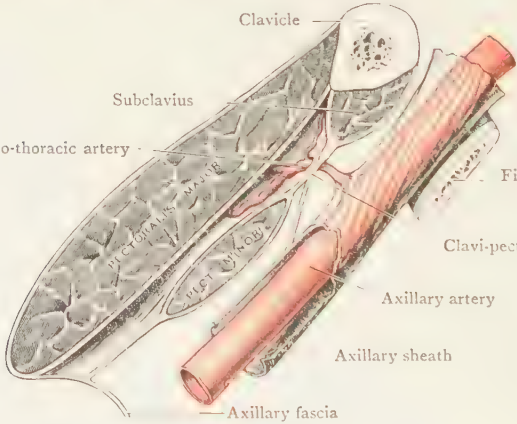


FIG. 11.—Diagram of the Clavi-pectoral Fascia.

and enclose between them a small muscle called the *subclavius*. The strongest part of the membrane is that which extends along the lower border of the subclavius, from the first rib to the coracoid process. The membrane is continuous below with the fascial sheath of the pectoralis minor, and posteriorly with the fascial sheath of the axillary vessels (Fig. 11). It is perforated, above the upper border of the pectoralis minor, by the cephalic vein, the acromio thoracic artery, and the lateral pectoral nerve. Note (1) *that the fibres of the membrane run medio-laterally*, (2) *that they are put on the stretch when the arm is abducted*, and (3) *that they are relaxed when the arm is by the side.* The surgeon takes advantage of these facts when he is ligaturing the first part of the axillary artery.

Dissection.—Cut through the anterior layer of the upper part of the clavi-pectoral fascia, expose the *subclavius muscle* and verify the attachments of the fascia to the clavicle; and then carefully remove the whole of the fascia.

Follow the *cephalic vein* to its junction with the axillary vein, and the *acromio-thoracic artery* and *lateral pectoral nerve* to their origins. Clean the proximal parts of the *axillary artery* and vein and the nerve cord from which the pectoral nerve springs. Find the small *communicating nerve* that connects the lateral and medial pectoral nerves, and crosses the axillary artery.

Clean the *pectoralis minor* muscle, without injuring the medial pectoral nerve, which pierces it.

The pectoralis minor is a triangular muscle which arises from the third, fourth and fifth ribs, close to their cartilages. Its fibres pass upwards and laterally, and its tendon of insertion is attached to the upper surface and the medial border of the coracoid process, near its tip.

When the muscle is in action it draws the scapula downwards and forwards, and depresses the shoulder. It is supplied by the *medial pectoral nerve.* The greater portion of the pectoralis minor is concealed by the pectoralis major; but the lower and medial part of its infero-lateral border appears on the side of the thorax below the pectoralis major, and its insertion is concealed by the anterior fibres of the deltoid.

Dissection. Throughout the dissection of the axilla, look for the *lymph glands* and note their positions; they lie mainly along the lines of the blood-vessels. If they are healthy they are very small, and are inconspicuous among the fat.

Clear away the fascia below the level of the pectoralis minor and open up the lower part of the axilla; remove also the deep fascia in the region of the lateral boundary of the axilla.

Begin below the lateral part of the pectoralis minor and clean the *coraco-brachialis* and the *short head of the biceps*, as they descend from the coracoid process. Find the axillary artery at the medial border of the coraco-brachialis. The trunk of the *median nerve* lies between the artery and the muscle, and the medial root of the nerve crosses the front of the artery. Pull the coraco-brachialis laterally and find the *musculo-cutaneous nerve* entering its deep surface. A little higher up, look for the branch of the musculo-cutaneous nerve that enters the coraco-brachialis to supply it.

Look in the interval between the axillary artery and vein, and find a long slender nerve called the *medial cutaneous nerve of the forearm*, and, behind it, a thicker nerve—the *ulnar.*

A slender nerve, called the *medial cutaneous nerve of the arm*, runs along the medial side of the axillary vein. Secure it, and follow it upwards to the point where it receives a communicating branch from the *intercosto-brachial nerve*, which runs across the axilla. Follow the intercosto-brachial nerve to the point where it emerges from the second intercostal space, and laterally to the arm, where it is distributed.

Separate the axillary fascia from the fascia of the arm in order to follow the branches of the intercosto-brachial nerve, and to gain better access to the medial and posterior walls of the axilla.

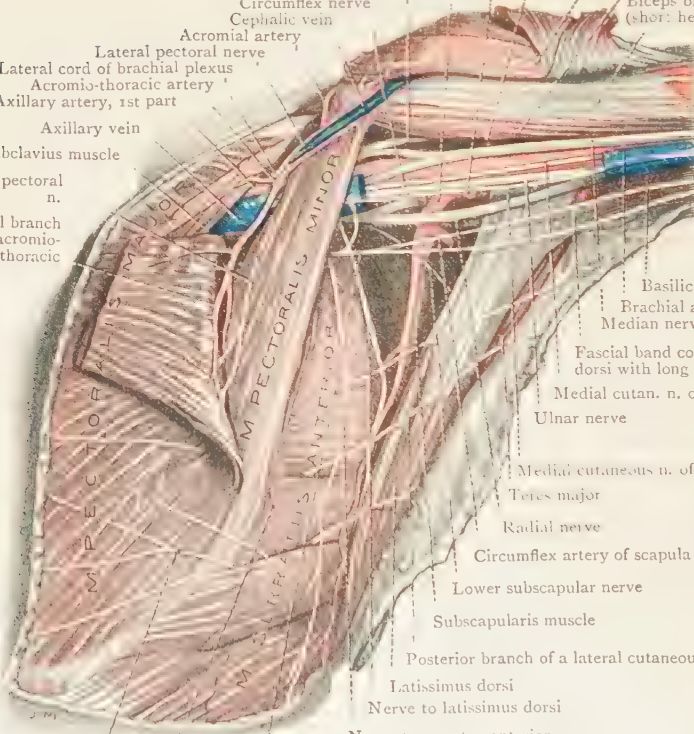


FIG. 12.—Contents of the Axilla exposed by the reflexion of the pectoralis major and the subjacent fascia, and the removal of the fat and the lymph glands. Part of the axillary vein removed to display the medial cutaneous nerve of the forearm and the ulnar nerve.

Turn now to the medial wall of the axilla, and find the anterior and posterior branches of the *lateral cutaneous nerves* as they emerge between the digitations of the serratus anterior, behind the infero-lateral border of the pectoralis minor. Trace them forwards and backwards. Clean the artery that runs

downwards along the infero-lateral margin of the pectoralis minor. It is called the *lateral thoracic artery*, and is a branch of the axillary. Secure the *nerve to the serratus anterior*, as it descends over the surface of that muscle, and then clean the muscle.

Lateral Cutaneous Branches of Intercostal Nerves.—These nerves emerge from the spaces between the ribs, and divide into anterior and posterior branches under cover of the serratus anterior muscle; and these branches pierce the muscle or appear between its digitations. The *anterior branches* appear, as a rule, about an inch in front of the corresponding posterior branches, and then pass forwards over the lower border of the pectoralis major muscle. From the lower members of this series some minute twigs are given to the external oblique muscle of the abdomen, which will be exposed by the dissectors of the Abdomen. The *posterior branches* run backwards, to the back of the trunk, over the lower or lateral border of the latissimus dorsi muscle (Fig. 12).

As a rule, the first intercostal nerve does not give off a lateral branch. That which springs from the **second** nerve is the largest of the series, and differs from the others in not dividing into an anterior and a posterior branch. It is termed the *intercosto-brachial nerve*, on account of its being distributed to the skin on the medial side and the back of the upper arm. To reach this destination it crosses the axilla and pierces the deep fascia of the arm a little below the posterior fold of the axilla. But before piercing the fascia it establishes communications and forms a plexiform arrangement in the axilla with the medial cutaneous nerve of the arm, and the lateral cutaneous branch of the third intercostal nerve. Branches from that plexus supply the skin of the floor of the axilla.

The *lateral cutaneous branch* of the **third** intercostal nerve divides into an anterior and posterior part, which are distributed in the ordinary way, except that the posterior branch sends twigs to the skin of the floor of the axilla and of the upper part of the medial side of the arm.

Dissection. Clean the lower parts of the large vessels and nerves and their branches and tributaries.

With chain and hooks, pull the axillary artery and the medial cutaneous nerve of the forearm towards the arm; displace the axillary vein in the opposite direction; identify the ulnar nerve again, pull it laterally and look for a slender contribution which it occasionally receives from the lateral cord of the brachial plexus.

Look also for a thick nerve, called the *radial nerve*, which lies behind the axillary artery ; pull the nerve medially ; follow its lateral border upwards ; and, at the lower border of the subscapularis muscle, find a medium-sized nerve, called the *circumflex nerve*, which bends backwards into the posterior wall of the axilla.

Near the circumflex nerve, find a large artery called the *subscapular*, and clean it. Follow it first towards its origin from the axillary artery, and find a large branch, called the *circumflex scapular artery*, which springs from it and turns backwards into the posterior wall of the axilla. Follow it next downwards and backwards along the lower border of the subscapularis muscle, taking care not to injure the intercosto-brachial nerve and the posterior branches of the 3rd, 4th, and 5th lateral cutaneous nerves, as they cross in front of the artery. Near its lower end, secure the *nerve to latissimus dorsi*, which crosses in front of the artery, on its way to supply that muscle. Return to the angle between the subscapular artery and its circumflex branch ; secure the *lower subscapular nerve*, and trace it into the teres major muscle.

Return to the radial nerve at the lower margin of the subscapularis muscle, and look for the branches that spring from the nerve near that point. They are the *posterior cutaneous nerve of the arm* and branches to the long and medial heads of the triceps muscle. They may arise separately or by a common stem. Trace them downwards.

The lateral thoracic and the subscapular branches of the axillary artery have now been found. Return to the axillary artery ; find its other branches, and clean them.

After the lower part of the axilla has been thoroughly cleaned, divide the pectoralis minor midway between its origin and insertion, and turn the two parts aside. Secure the *upper subscapular nerve* as it enters the upper part of the subscapularis ; and then clean the contents of the upper part of the axilla thoroughly.

When that has been done, the contents of the space must be studied in detail.

Axillary Lymph Glands. The lymph glands in the axillary region are spoken of, collectively, as the axillary glands, but for convenience of description, and to facilitate a more precise knowledge of their connexions and associations, they are subdivided into several subordinate groups. Some of the glands have been removed as the dissection proceeded, and others are so small that they may have escaped the attention of the dissector ; but, during the course of the dissection of the armpit, he will have noted at least four groups of glands. (1) A lateral or **brachial group** of six or more glands which lie along the axillary vessels. They receive the lymph vessels from the greater part of the upper limb, and may receive lymph from the deep part of the mammary gland also. (2) An anterior or **pectoral group** which lies in the angle between the anterior and medial walls

of the axilla. This group is subdivisible into two parts:—(*a*) An upper group of two or three small glands which lie behind the pectoralis major in the region of the second and third intercostal spaces, and receive most of the lymph of the mammary gland (p. 28); (*b*) a lower group which lies along

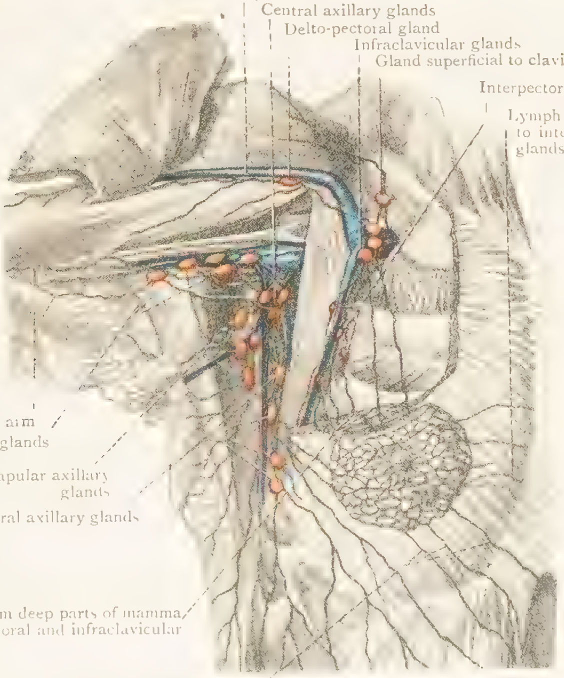


FIG. 13.—The Lymph Glands and Vessels of the Axilla and Mamma.

the lateral thoracic vessels, and receives lymph from the side of the thorax. (3) A posterior or subscapular group which lies along the subscapular vessels on the posterior wall of the axilla, and receives lymph vessels from the back. (4) The delto-pectoral glands (p. 30).

In addition to the lymph glands which are usually seen in an ordinary dissection, there are three other groups of glands. (*a*) *Interpectoral glands*, from one to four, which lie on the

anterior surface of the pectoralis minor ; they receive lymph from the deep part of the mammary gland by lymph vessels which pierce the pectoralis major. (*b*) The *central glands*, which are very variable ; they lie either on the surface of the axillary fascia, in a pocket of its substance, or deep to it in the fat of the middle part of the axilla ; they have no afferents from any definite region, but connect the other groups together. (*c*) The *infraclavicular glands*, which lie in the apex of the axilla behind the clavi-pectoral fascia. They receive efferents from all the lower groups ; and their own efferents unite to form a vessel called the subclavian lymph trunk, which terminates usually in the subclavian vein.

Axillary Artery.—The axillary artery is the chief artery of the upper limb. It begins, as a continuation of the subclavian artery, at the outer border of the first rib, and enters the axilla through its apex. It lies, for a short distance, on the medial wall of the axilla, crosses the fat in the angle between the medial and posterior walls, and then runs along the lateral wall to the lower border of the teres major ; there it leaves the axilla and becomes the brachial artery. The direction which the artery takes varies with the position of the limb. When the arm is at a right angle with the body, the direction is that of a straight line from the middle of the clavicle to the middle of the bend of the elbow. When the arm is by the side, the artery describes a curve with the convexity directed laterally ; and if the arm is raised above the head, the curve formed by the artery is convex in the reverse direction.

For convenience of description, the axillary artery is usually divided into three parts—the part above the pectoralis minor, the part behind it, and the part below it. They are known respectively as the first, second, and third parts. The three thick cords that form the lower part of the brachial plexus are closely related to the first and second parts of the artery ; and the large nerves that spring from the cords are grouped round the third part.

The *first part* of the axillary artery lies very deeply. It is covered, *anteriorly*, by the skin, superficial fascia, deep fascia, the clavicular part of the pectoralis major, the clavi pectoral fascia and the vessels and nerves superficial to it. Even when all these are removed the vessel is not completely exposed, because it is enveloped, along with the axillary vein and brachial

plexus, in a funnel-shaped sheath, which is prolonged upon them from the deep fascia of the neck (Fig. 11); and it is crossed by the loop of communication between the two pectoral (anterior thoracic) nerves which lies in front of the sheath. *Posteriorly*, it is related to the first intercostal space and the first digitation of the serratus anterior muscle; the nerve to the serratus anterior and the medial cord of the

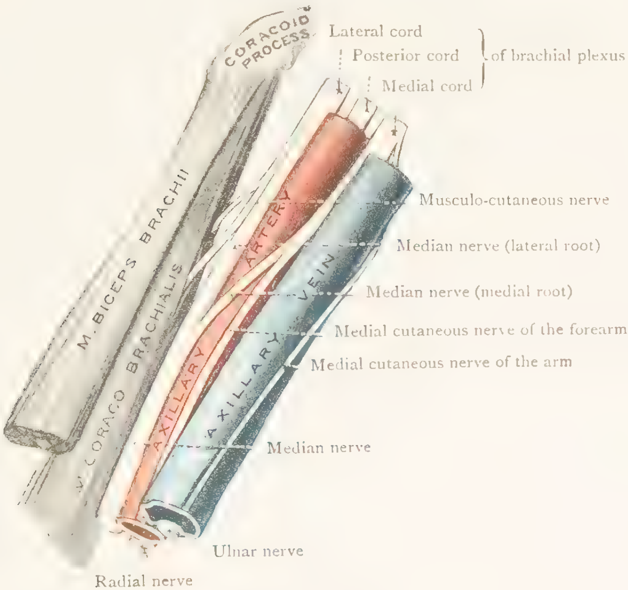


FIG. 14.—Diagram to show relations of Axillary Vessels and Nerves.

brachial plexus also pass behind it. The axillary vein is on its *medial side*, and overlaps its anterior surface slightly; whilst *above* and to its *lateral side* there are the lateral and posterior cords of the brachial plexus.

The *second part* is placed behind the two pectoral muscles, and has the three cords of the brachial plexus disposed around it. The medial cord lies along its medial side, the lateral cord along its lateral side, and the posterior cord behind it. The axillary vein is still medial to it, but is separated by the medial cord. Strictly speaking, the second part of the artery

is not in apposition with any muscle posteriorly, being separated from the subscapularis muscle by areolo-fatty tissue.

The *third part* is the longest part. It is superficial in its lower half, because the anterior wall of the axilla does not extend so far down as the posterior wall does. Therefore, whilst the upper half of the third part is covered by the pectoralis major and is crossed at the lower border of the pectoralis minor by the medial root of the median nerve, its lower half is covered only by the skin and fasciæ. *Behind* it, from above downwards, there are the subscapularis, the tendon of the latissimus dorsi, and the teres major; but it is separated from the subscapularis muscle by both the circumflex nerve and the radial nerve, and from the latissimus dorsi and teres major by the radial nerve alone. The coraco-brachialis muscle is on its *lateral* side, and also the median and musculo-cutaneous nerves, which lie between the muscle and the artery. The axillary vein is on the *medial* side of the artery, with the medial cutaneous nerve of the forearm and the ulnar nerve between the artery and vein. More medially still, the medial cutaneous nerve of the arm lies along the medial side of the vein (Fig. 14).

The **branches of the axillary artery** have been seen at different stages of the dissection. They should now be examined more fully (Fig. 15). They are :—

Superior thoracic	from the first part.	Subscapular . Anterior circumflex humeral . . Posterior circumflex humeral . .	from the third part
Acromio-thoracic Lateral thoracic	from the second part.		

The **superior thoracic artery** is a small branch that arises at the lower border of the subclavius. It ramifies upon the upper part of the medial wall of the axilla and supplies twigs to adjacent structures (Fig. 15).

The **acromio-thoracic artery** is a short, wide trunk which takes origin under cover of the pectoralis minor. It winds round the upper border of that muscle, pierces the clavi-pectoral fascia, and immediately divides into four small branches which diverge from one another and supply neighbouring structures; the largest of them runs downwards between the pectoral muscles. The *veins* that accompany those branches end in the cephalic vein.

The **lateral thoracic artery** takes the infero-lateral border

of the pectoralis minor as its guide, and proceeds downwards and medially to the side of the thorax. It gives branches to the neighbouring structures, including the mammary gland.

The **subscapular artery** is the largest branch of the axillary. It arises at the lower border of the subscapularis, and runs downwards and backwards, along that border, to

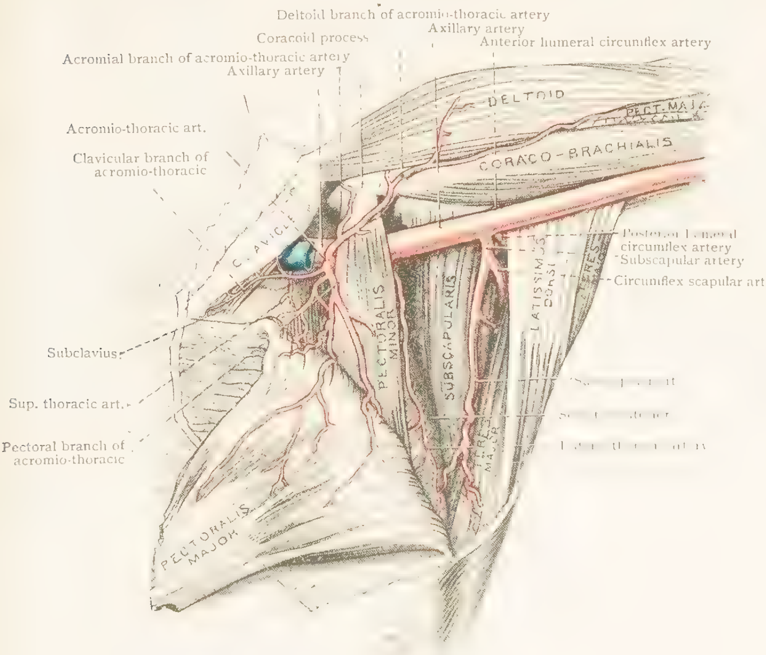


FIG. 15.—Dissection of the Axillary Artery and its Branches.

the inferior angle of the scapula, giving off branches to neighbouring structures. Its largest branch is the *circumflex scapular artery*, which springs from it an inch below its origin, and winds backwards around the lateral margin of the scapula to reach the infraspinous fossa.

The two circumflex humeral arteries arise at the same level—a short distance below the subscapular artery.

The **posterior circumflex humeral artery** is much the larger of the two. Only a small portion of it can be seen at

the present stage. It springs from the back of the axillary artery, and at once passes backwards, with the circumflex nerve, in the interval between the subscapularis and teres major muscles on the medial side of the surgical neck of the humerus, below the shoulder joint; and, curving round the surgical neck, under cover of the deltoid muscle, it is spent chiefly in supplying that muscle.

The **anterior circumflex humeral artery** takes origin from the lateral aspect of the axillary artery, and runs laterally, in front of the surgical neck of the humerus, under cover of the coraco-brachialis and short head of the biceps brachii. Reaching the bicipital groove, it divides into two branches, one of which runs up to the shoulder joint, while the other anastomoses with twigs of the posterior circumflex artery.

Axillary Vein.—This vessel has the same extent as the artery. It begins at the lower border of the teres major, as the continuation of the basilic vein, and it becomes the subclavian vein at the outer margin of the first rib. It lies along the medial side of the axillary artery, overlapping it anteriorly; and as the arm is abducted from the side the vein passes more and more in front of the artery.

At the lower margin of the subscapularis it receives the two *venæ comitantes* which lie along the sides of the brachial artery and of the distal part of the axillary artery; and, above the level of the pectoralis minor, it is joined by the cephalic vein. Its other tributaries correspond to the branches of the axillary artery, except the acromio-thoracic.

Subclavius.—This small muscle lies immediately below the clavicle, enclosed between two layers of the clavi pectoral fascia. It takes origin, by a short, rounded tendon, from the upper surface of the first costal arch, at the junction of the bone with the cartilage; and the fleshy belly is inserted into the shallow groove on the lower surface of the clavicle. The nerve of supply is derived from the fifth and sixth cervical nerves and enters the posterior surface of the muscle. When the muscle contracts it depresses the clavicle and draws it slightly forwards.

Dissection. When the subclavius has been examined, divide it horizontally, in order to find the costo-clavicular ligament, which lies behind its medial end.

At this stage, examine the *sterno-clavicular joint* with the aid of the dissectors of the Neck. Detach the clavicular head of the sterno-mastoid from the clavicle (if the dissectors of the neck

have not done that already), and pull the sternal head of the muscle towards the median plane in order to expose the upper and anterior surfaces of the joint.

Sterno-clavicular Joint.—This is a synovial joint at which the medial end of the clavicle articulates with the shallow socket provided by the clavicular notch of the manubrium sterni and the upper surface of the first costal cartilage. It helps to increase the range of the forward, backward, and

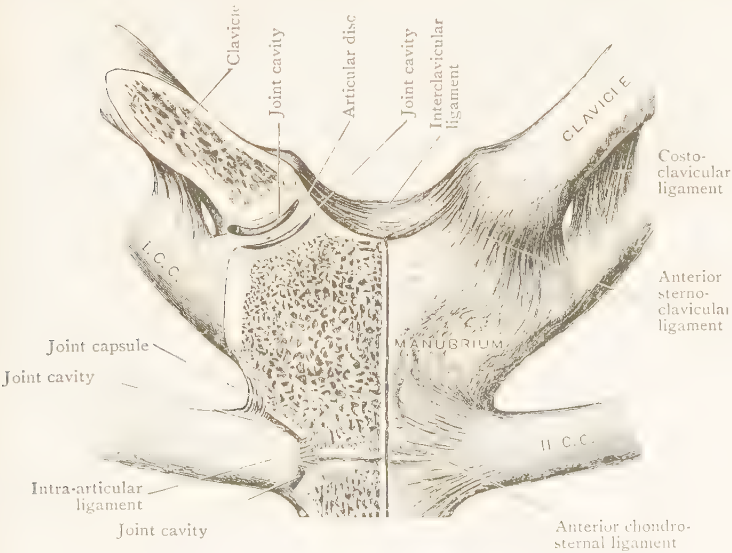


FIG. 16.—Sterno-clavicular and Costo-sternal Joints.

upward movements of the arm. The joint is enclosed in a capsule attached to the cartilage and the bones just beyond the margins of the articular surfaces. The anterior and posterior parts of the **capsular ligament** are very strong and are called the **anterior** and **posterior sterno-clavicular ligaments.** Associated with the joint there are an articular disc and two accessory ligaments—the interclavicular and the costo-clavicular.

The **articular disc** is a nearly circular plate of fibro-cartilage situated in the interior of the joint, which it divides into two compartments. It is attached to the anterior and

posterior ligaments, to the upper part of the medial end of the clavicle, and to the sternum and first costal cartilage at their junction; it therefore separates the clavicle from the sternum, but not from the first costal cartilage.

The **interclavicular ligament** is fused with the upper part of the capsular ligament. It passes between the medial ends of the two clavicles, dipping down to be attached also to the upper border of the manubrium.

The **costo-clavicular ligament** is a strong, thick, flattened band that lies behind the subclavius muscle. It is attached to the first rib and its cartilage at their junction, and extends upwards and laterally to a rough impression on the lower surface of the clavicle near its medial end.

Behind the joint there are two thin, flat ribbons of muscle that extend up into the neck—the *sterno-hyoid* muscle, and, behind it, the *sterno-thyroid*. They separate the right joint from a large artery called the *innominate*, and the left joint from the *left innominate vein*.

The capsule of the joint is supplied by the *medial supra-clavicular nerves*.

Dissection. Cut through the anterior part of the capsule of the joint close to the sternum. Examine the root of the neck just above the joint. Identify the *sterno-hyoid* and *sterno-thyroid* muscles, and a small vein, called the *anterior jugular*, that runs laterally in front of them just above the level of the joint. Push the vein out of the way. Detach the fibres of the sterno-hyoid that arise from the posterior ligament. Push the knife down behind the joint, cut the posterior ligament, and pull the clavicle laterally.

The articular disc is now exposed. Examine its attachments. Detach it from the first rib; then carry the knife laterally below the clavicle and cut through the lower part of the capsule and the costo-clavicular ligament. Displace the clavicle upwards and laterally to bring the whole of the brachial plexus into view.

Brachial Plexus. This important plexus is formed by the anterior primary rami of the lower four cervical nerves and the greater part of the anterior primary ramus of the first thoracic nerve. The plexus is reinforced, above, by a small twig of communication which passes from the fourth to the fifth cervical nerve, and, below, by a similar connecting twig that passes upwards, in front of the neck of the second rib, from the second to the first thoracic nerve.

The manner in which the nerves join to form the plexus is very constant. The *fifth* and *sixth cervical nerves* unite to

form an *upper trunk*; the *seventh* remains single and proceeds laterally as a *middle trunk*; whilst the *eighth* and *first thoracic nerves* join to form the *lower trunk*. A short distance

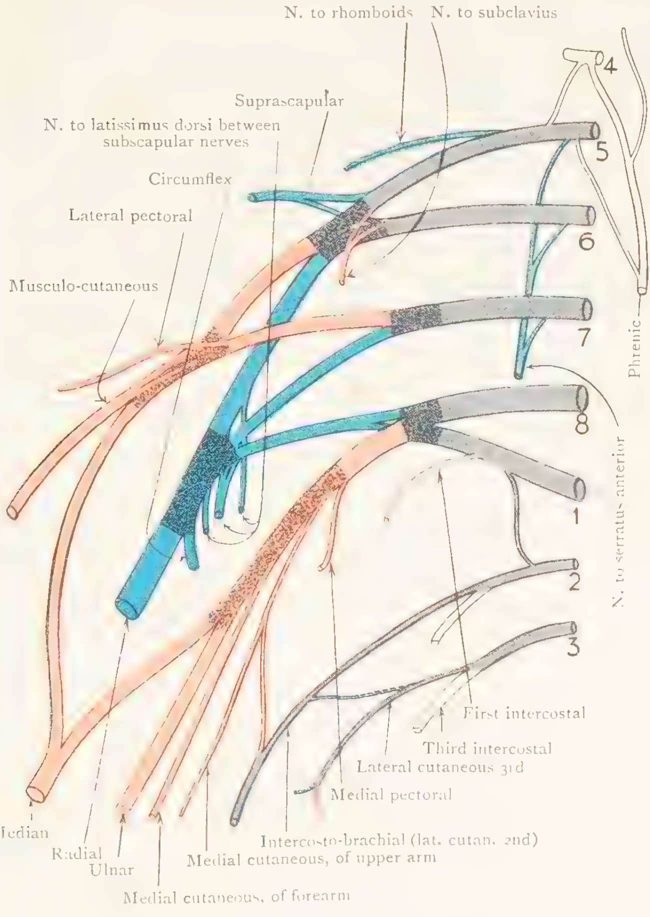


FIG. 17.—Diagram of the right Brachial Plexus.

above the clavicle each of the three trunks splits into an *anterior* and a *posterior division*. When the three anterior divisions are raised on the handle of a knife, the three posterior divisions will be seen uniting to form the *posterior cord* of

the plexus. It should be noted that the lowest or most medial of the posterior divisions is much smaller than the other two. Of the three anterior divisions, the *two upper* unite to form the *lateral cord* of the plexus, whilst the *lower* passes distally by itself as the *medial cord*. The three cords give off most of the branches that supply the upper limb (Figs. 17, 19).

The plexus may be divided, therefore, into four stages:—

First Stage . .	Five separate nerves (viz., lower four cervical and first thoracic).
Second Stage .	Three trunks (viz., upper, middle, and lower).
Third Stage .	Three anterior divisions and three posterior divisions.
Fourth Stage .	Three cords (viz., lateral, medial, and posterior).

The plexus begins at the lateral border of a muscle of the neck called the *scalenus anterior*, deep to the lower third of the posterior border of the sterno-mastoid. It passes through the lower part of the posterior triangle of the neck, and behind the middle third of the clavicle, into the upper part of the axilla; and it ends behind the infero-lateral margin of the pectoralis minor near the coracoid process, where it breaks up into the large nerves of the upper limb. Its termination is therefore at the junction of the second and third parts of the axillary artery, and, consequently, the first and second parts of the artery are related to the cords of the plexus, while the third part is related to the large nerves that spring from them.

As a rough guide to their position, it may be stated that the first two stages are in the neck, the third stage is behind the clavicle, and the last stage is in the axilla (Figs. 18, 19). The branches of the plexus spring from its roots, and from its trunks, and from its cords.

The upper part of the plexus and the branches of the roots and trunks must be found and cleaned by the dissector of the Head and Neck. The lower part and the branches of the cords must be displayed by the dissector of the Upper Limb. But four of the nerves that arise in the neck supply muscles of the upper limb; their cervical parts must be examined by the dissector of the Upper Limb, who must study the arrangement of the cervical part of the plexus also; and the dissector of the Head and Neck should seize the opportunity of renewing his knowledge of the relations and branches of the plexus in the axilla.

Relations of Brachial Plexus in Axilla.—*In front of* the plexus there are skin, the fasciæ, the platysma, the pectoralis major, the pectoralis minor, the clavi-pectoral fascia, the cephalic vein, and the axillary artery. *Behind it* there are

the upper serration of the serratus anterior, an interval filled with fat and fascia between the medial and posterior walls of the axilla, and the subscapularis muscle. The cords lie close together behind, above, and lateral to the first part of the axillary artery, but are arranged around the second part in the positions implied in their names—lateral, medial, and posterior (Fig. 14).

The Branches of the Plexus.—The *branches that arise in the neck to be distributed in the upper limb* are the nerve to the subclavius, the nerve to the rhomboid muscles, the nerve to the serratus anterior, and the suprascapular nerve.

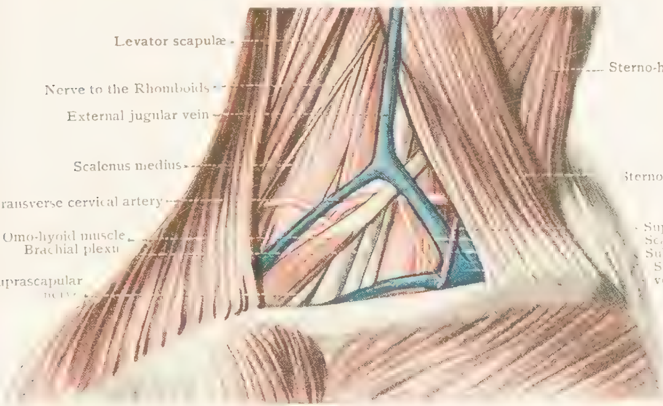


FIG. 18.—Dissection of the lower part of the Posterior Triangle of the Neck, showing the Supraclavicular Part of the Brachial Plexus.

The **nerve to the rhomboids** (dorsalis scapulæ) arises from the fifth cervical nerve, runs downwards and laterally a little above the brachial plexus, disappears among muscles, and will be encountered again when the back is dissected.

The **suprascapular nerve** springs from the fifth and sixth cervical nerves at their junction, runs laterally and downwards immediately above the plexus, disappears under a large muscle called the trapezius, and will be further dissected in the scapular region.

The **nerve to subclavius** also arises from the fifth and sixth cervical at their junction. It descends in front of the plexus to enter the back of the subclavius muscle.

The **nerve to serratus anterior** (long thoracic) runs most

of its course in the axilla. It arises from the fifth, sixth, and seventh cervical nerves by three separate roots. The roots descend behind the cervical part of the brachial plexus, and are therefore concealed by it. The upper two roots unite to form one stem which enters the axilla by crossing the first digitation of the serratus anterior behind the first part of the axillary artery, and gives twigs to the upper part of the serratus. The lower root descends close by that stem and joins it in the axilla. The nerve then runs downwards over the surface of the serratus anterior, about the junction of the anterior and middle thirds of the medial wall of the axilla, giving off twigs to each of its digitations.

The *branches from the cords* are—

From the lateral cord :

- **Lateral pectoral** (lateral anterior thoracic) (from C. V., VI., VII.).
- **Musculo-cutaneous** (from C. V., VI., VII.).
- **Lateral root of median** (from C. V., VI., VII.).

From the medial cord :

- **Medial pectoral** (medial anterior thoracic) (from C. VIII., T. I.)
- **Medial cutaneous, of forearm** (from C. VIII., T. I.).
- **Medial cutaneous, of arm** (from C. VIII., T. I.).
- **Medial root of median** (from C. VIII., T. I.).
- **Ulnar** (from C. VII., VIII., T. I.).

From the posterior cord :

- **Upper and Lower Subscapular** (from C. V., VI.).
- **N. to latissimus dorsi** (thoraco-dorsal) (from C. VI., VII., VIII.).
- **Circumflex** (axillary) (from C. V., VI.).
- **Radial** (from C. V., VI., VII., VIII., T. I.).

This table shows the spinal nerves from which the fibres of the several branches are usually derived.

Pectoral Nerves (Anterior thoracic). The pectoral nerves supply the pectoral muscles. They are two in number, the lateral and the medial.

The *lateral pectoral nerve* springs from the lateral cord, passes forwards across the lateral side of the first part of the axillary artery, communicates, in front of the artery, with the medial nerve, pierces the clavi-pectoral fascia, and breaks up into branches which end in the pectoralis major.

The *medial pectoral nerve* is smaller than the lateral. It springs from the medial cord, passes forwards between the axillary artery and vein, communicates, in front of the artery, with the lateral nerve, gives twigs of supply to the pectoralis

minor, then pierces that muscle and ends in the pectoralis major, which it supplies.

The pectoralis major is therefore supplied by both

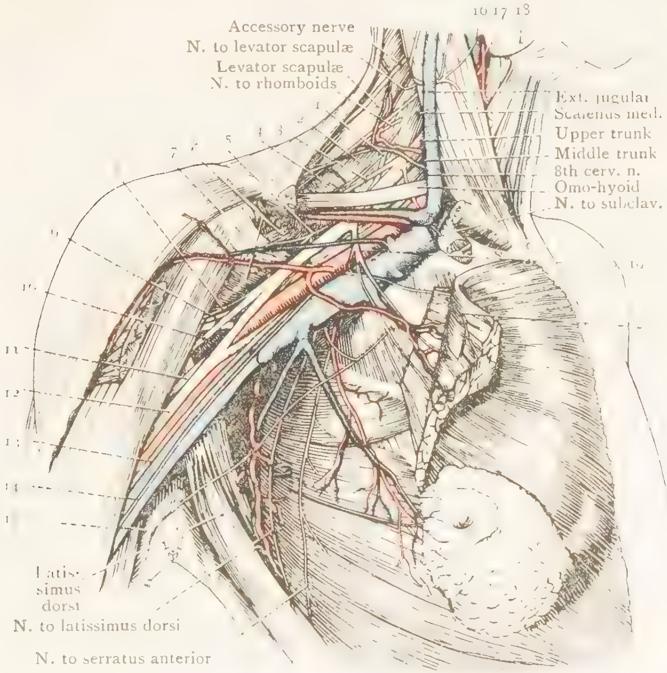


FIG. 17.—Dissection to show the General Relations of the Brachial Plexus.

1. Nerve to serratus anterior.	11. Radial nerve.
2. Scalenus medius.	12. Median nerve.
3. Supra-scapular nerve.	13. Medial cutaneous nerve of forearm.
4. Serratus anterior.	14. Medial cutaneous nerve of arm.
5. Upper subscapular nerve.	15. Intercosto-brachial nerve.
6. Subscapularis.	16. Internal jugular vein.
7. Pectoralis minor.	17. Superior thyroid artery.
8. Nerve to coraco-brachialis.	18. Submandibular gland.
9. Circumflex nerve.	19. Lateral pectoral nerve.
10. Musculo-cutaneous nerve.	20. Medial pectoral nerve.

pectoral nerves, the pectoralis minor by the medial nerve alone.

Subscapular Nerves.—The subscapular nerves are two in number the *upper* and the *lower*. They spring from the posterior cord of the plexus. After a very short course the

upper nerve sinks into and supplies the upper and posterior part of the subscapularis. The lower subscapular nerve passes downwards and laterally, gives branches to the lower part of the subscapularis, then passes behind the subscapular

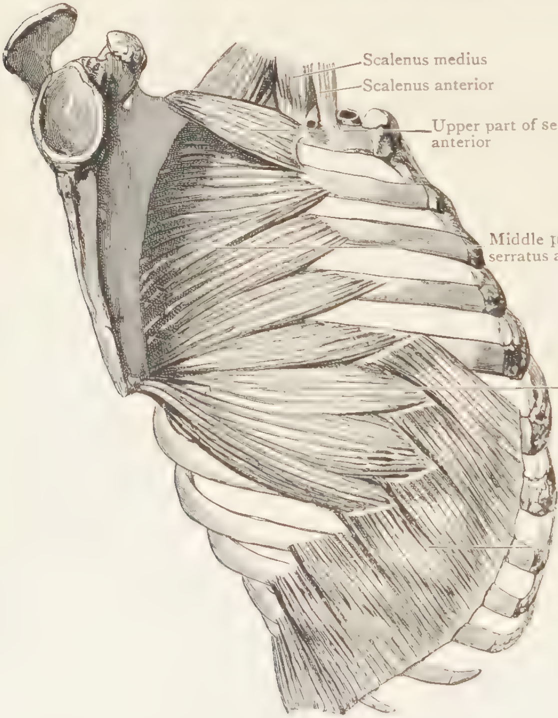


FIG. 20.—Serratus Anterior muscle and origin of the External Oblique muscle ; the scapula is drawn away from the side of the chest.

vessels at the origin of the circumflex scapular artery, and ends in the teres major, which it supplies.

The **nerve to latissimus dorsi** (thoraco dorsal) springs from the posterior cord, passes obliquely downwards and laterally, through the axilla, and joins the subscapular artery near the lower part of the lateral border of the subscapularis muscle. After crossing in front of the artery, it enters the deep surface of the latissimus dorsi at the inferior angle of the scapula.

The other branches which spring from the cords will be described later.

Serratus Anterior. This large and powerful muscle arises by fleshy digitations from the upper eight ribs, about midway between their angles and cartilages. The slips

FIG. 21.—Costal aspect of the Scapula with the Attachments of Muscles mapped out.

are arranged on the chest wall so as to present a gentle curve convex forwards. The lower three interdigitate with the external oblique muscle of the abdomen. The serratus anterior is inserted into the entire length of the medial margin of the scapula, and it falls naturally into three parts.

(*a*) The *upper part*, composed of the large, first digitation alone, arises from the first and second ribs, and from a tendinous arch between them. The fibres converge, to be inserted into a triangular surface on the costal aspect of the upper angle of the scapula. (*b*) The *middle part* consists of the two digitations from the second and third ribs, and its fibres spread out to form a thin sheet which is inserted into the anterior lip of the medial margin of the scapula, between the insertions of the upper and lower portions. (*c*) The *lower part* is formed by the remaining digitations of the muscle. They converge to form a thick mass which is inserted into a rough surface upon the costal aspect of the inferior angle of the scapula.

The deep surface of the serratus anterior is in contact with the chest wall.

It is the most powerful protractor of the whole upper limb. It is supplied by the special nerve from the fifth, sixth, and seventh cervical nerves (p. 49).

Dissection.—**At the end of the fifth day, after the dissector has examined the serratus anterior and carefully revised the contents of the axilla, he must replace the clavicle, pack the axilla with tow or rags steeped with preservative solution, and fix the skin flaps to the wall of the thorax with a few stitches.**

DISSECTION OF THE BACK

When the dissector returns on the sixth day he will find that the body has been placed face downwards, with blocks supporting the chest and the pelvis. It will remain in that position for five days, and during the first two of those the dissector of the Upper Limb will examine the structures which connect the limb with the back of the trunk.

As the back is dissected the following are the parts which must be examined :—

1st day:

1. The cutaneous vessels and nerves of the back.
2. The trapezius muscle.
3. The latissimus dorsi muscle.

2nd day:

4. The rhomboid muscles and their nerve.
5. The levator scapulæ muscle.
6. The accessory nerve and the nerves from the cervical plexus which supply the trapezius.
7. The transverse cervical artery and its two terminal branches.
8. The inferior belly of the omo-hyoid muscle.
9. The suprascapular artery and nerve.

This dissection must be completed *in two days*, in order that the dissector of the Head and Neck may be enabled to continue the deeper dissection of the back.

The *first day's work* should comprise—(1) Surface anatomy; (2) the reflexion of the skin; (3) the dissection of the cutaneous nerves and vessels; and (4) the cleaning of the latissimus dorsi and trapezius muscles. The remainder of the dissection can be undertaken on *the second day*.

Surface Anatomy. The **scapula** overlies a large area of the upper part of the back of the thorax, including the second to the seventh ribs; and, though it is thickly covered with muscles, a great part of its outline can be made out. Find the **acromion** at the top of the shoulder. Draw your finger along the bony ridge that runs in a medial direction and backwards and slightly downwards from the acromion. That is the **crest** of the spine of the scapula. It ends at the **medial border** of the scapula. Palpate the medial border through the muscles that cover it, and trace it to the **upper** and **lower angles** of the scapula. The scapula is very movable. When the arms are folded across the chest, the scapulæ are drawn apart, and their medial borders are four or five inches from the median line. When the arm hangs by the side, the medial border is one or two inches from the median line; the upper angle overlies the **second rib**; the lower angle—much more easily felt than the upper—usually overlies the **seventh rib**.

The rib felt below the scapula is therefore usually the **eighth rib**; and the lower ribs can be counted from it. If the **twelfth** is long enough to reach beyond the sacro spinalis (*i.e.* the mass of muscle in the small of the back), its tip is about an inch—more or less—above the iliac crest.

The **iliac crest** is the bony ridge in the lower margin of the waist. Trace it backwards. Its posterior end is called the **posterior superior iliac spine,** and is the bone felt in the floor of a shallow dimple in the skin above the buttock about two inches from the median line. The lowest two portions of the backbone are called the sacrum and the coccyx. The uneven bone felt between the right and left dimples is the back of the **sacrum.** Usually it has three spines that can be felt in the median line. The **coccyx** is the bone felt deeply between the buttocks.

The *median furrow* of the back varies in depth with the

muscularity of the body. It is deepest in the upper part of the loin; it fades away inferiorly at the third sacral spine and is succeeded by the cleft between the buttocks. The **spines**

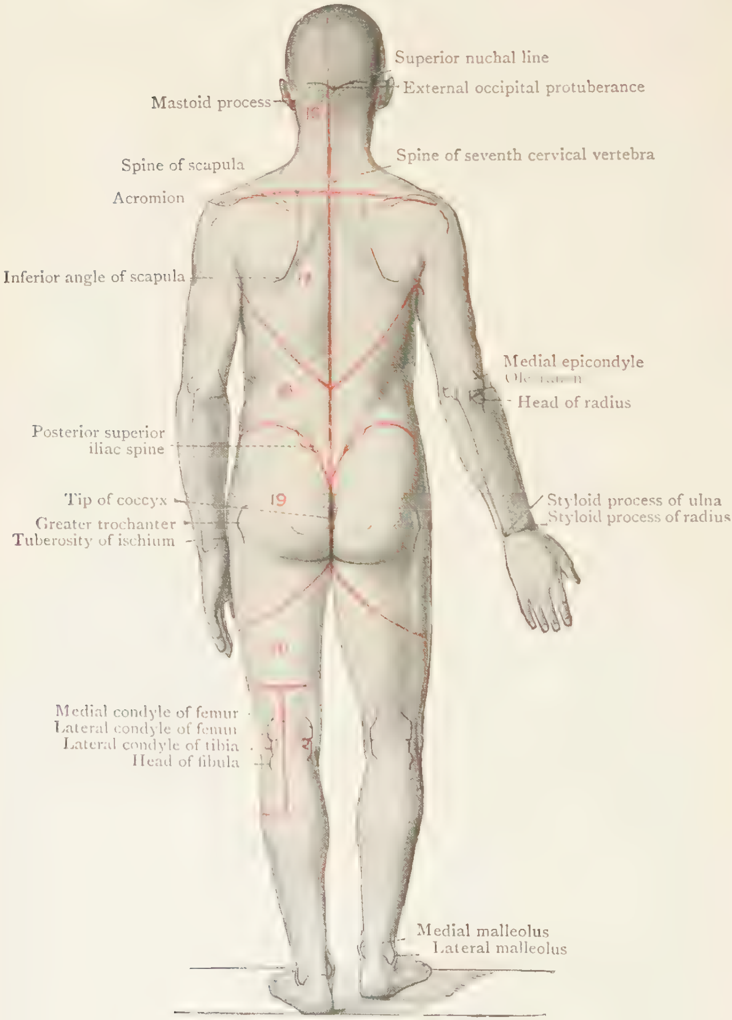


FIG. 22.—Landmarks and Incisions.

of the vertebræ are felt in the furrow: pass the finger over them. Note that their tips do not all lie in the median line: some are deflected to one side or the other. The spines are the only parts of the vertebral column that are subcutaneous or easily felt, but it is very seldom possible to identify individual spines directly. Some of them, however, can be identified because they are at the same level as recognisable landmarks; and the positions of the others can be gauged from them. The **second sacral** spine is at the level of the dimple of the posterior iliac spine; the **fourth lumbar** is at the level of the highest part of the iliac crest; the **seventh thoracic** is at the level of the lower angle of the scapula; and the **third thoracic** is at the level of the point where the crest and medial border of the scapula meet. The **seventh cervical** spine can be identified directly: it is the uppermost of the knobs at the root of the back of the neck. Pass your finger upwards over the other cervical spines. The uppermost one felt is the spine of the **second cervical** vertebra (the first has no spine); it is about two inches below the **external occipital protuberance.** That protuberance is the median knob on the back of the head. Put your finger on the knob; draw it in a lateral direction and feel the curved ridge on the back of the skull called the **superior nuchal line.** Between the muscles of the two sides of the back of the neck there is a fibrous partition called the **ligamentum nuchæ**; its posterior edge stretches from the occipital protuberance to the seventh cervical spine. The upper part of the first muscle encountered in the dissection of the back—the *trapezius*—arises from the nuchal line, the protuberance and the ligamentum nuchæ.

Dissection.—Reflexion of the Skin.—Incisions (Fig. 22).—1. From the tip of the coccyx, upwards, along the median line of the body, to the spine of the seventh cervical vertebra. 2. From that point, transversely to the tip of the acromion. 3. From the lower extremity of the median incision in a curved direction laterally and forwards, along the iliac crest, to within two inches of the anterior end of the crest. 4. An oblique incision from the spine of the first lumbar vertebra, upwards and laterally, to the posterior fold of the axilla, and along that fold to the arm. The two large flaps (17 and 18, Fig. 22) which are now mapped out on the back must be carefully reflected.

Superficial Fascia.—In subjects which have been allowed to lie for some time on the back, the superficial fascia is usually more or less infiltrated with fluid which has gravi-

tated into its meshes; otherwise it has the ordinary characters of superficial fascia (p. 3).

Dissection.—When searching for the cutaneous nerves, cut boldly down through the superficial fascia, in the direction in which the nerves run (Fig. 23), until the deep fascia is reached. It is there that the main trunks are to be found, and in a well-injected subject the cutaneous arteries will serve as guides. Trace them laterally through the superficial fascia.

Cutaneous Nerves and Vessels. The *cutaneous nerves* of the back are derived from the posterior primary rami of the spinal nerves. As the posterior primary rami pass backwards, they divide into medial and lateral branches. Both branches supply twigs to the muscles amongst which they lie; but the one or the other contains also some sensory fibres which come to the surface, in the shape of a cutaneous nerve, to supply the skin.

In the *thoracic region*, the *upper six* or *seven* cutaneous nerves are the terminations of the medial branches of the posterior primary rami. They become superficial close to the vertebral spines, and are to be sought for near the median plane. It is not uncommon to find one or more of them piercing the trapezius one or two inches lateral to the line of emergence of the others. The branch which comes from the second thoracic nerve is the largest of the series; and it may be traced laterally, across the spine of the scapula, towards the shoulder.

The *lower five* or *six* cutaneous nerves in the *thoracic region* are the terminal twigs of the lateral branches of the posterior primary rami of the thoracic nerves; and, consequently, they must be looked for at some distance from the middle line of the back. The upper nerves of this group reach the surface after piercing the latissimus dorsi muscle on the line of the angles of the ribs. The lower nerves of the group appear at the lateral margin of the sacrospinalis muscle by piercing the *lumbar fascia*, which is the very thick deep fascia of the small of the back.

Each of the cutaneous branches derived from the thoracic nerves divides into two branches, of which the larger runs laterally and downwards for a varying distance in the superficial fascia.

It is important to note that the area of skin supplied by

each of these cutaneous nerves is placed at a lower level than the origin of the posterior ramus from which it arises.

In the *lumbar region*, three cutaneous nerves reach the

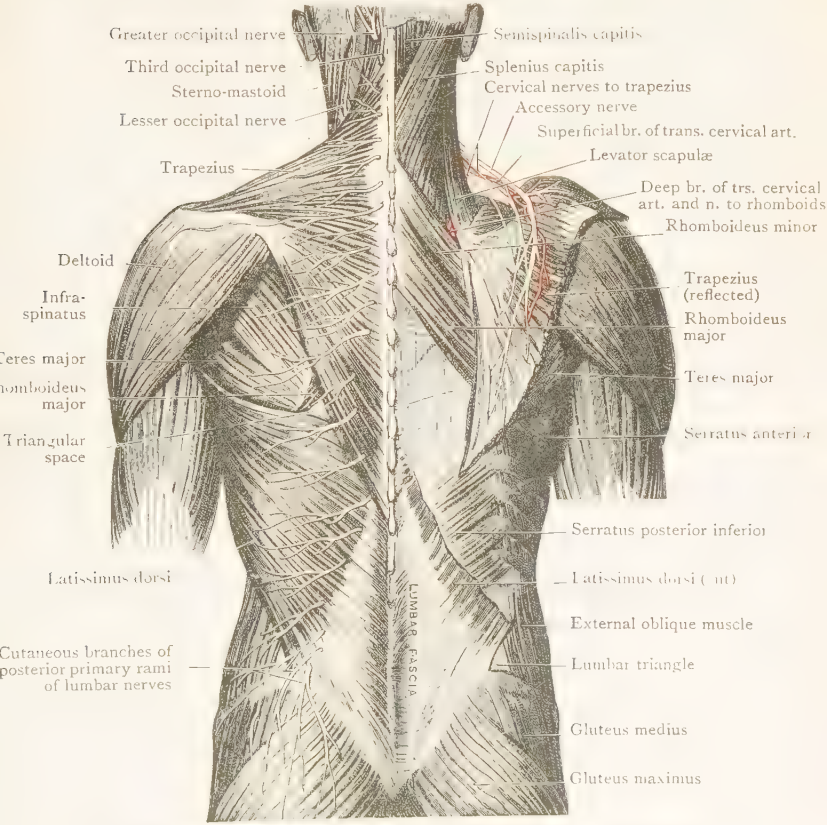


FIG. 23.—Dissection of the Superficial Muscles and Nerves of the Back.

surface after piercing the lumbar fascia at the lateral margin of the sacrospinalis muscle, a short distance above the iliac crest. They are the terminal twigs of the lateral branches of the posterior primary rami of the upper three lumbar nerves; and they differ from the nerves above, inasmuch as they turn

downwards over the iliac crest to supply the skin of the gluteal region (Fig. 23).

The *cutaneous arteries* which accompany the cutaneous nerves of the back are derived from the posterior branches of the intercostal and lumbar arteries.

Dorsal Muscles attaching the Limb to the Trunk.

There are five muscles in this group, arranged in two strata. The trapezius and the latissimus dorsi form the *superficial stratum*. Both are broad and flat, and they cover the greater part of the back of the trunk, from the occiput to the iliac crest. The trapezius lies over the back of the neck and the thorax. The latissimus dorsi lies on the thorax and in the loin. The *deeper stratum* of muscles, composed of the levator scapulæ and the two rhomboid muscles, is under cover of the trapezius.

Dissection.—Clean away the remains of the superficial fascia in the area of the trapezius, but do not injure the deep fascia or the cutaneous nerves; then clean the trapezius. The trapezius belongs only in part to the dissector of the Upper Limb. The portion of it which lies above the spine of the seventh cervical vertebra is the property of the dissector of the Head and Neck, and must be dissected by him. The two dissectors should work in conjunction with each other; and when the entire muscle is exposed, each should give the other an opportunity of studying it in its entirety.

Place the arm close to the trunk and drag the scapula forwards over the end of the block which supports the thorax.

If the dissection is being made on the *right side*, cut through the deep fascia from the seventh cervical spine to the acromion; the incision will correspond with the direction of the fibres of the trapezius at that level. Work gradually downwards, raising the fascia from the surface of the muscle.

On the *left side*, make the preliminary incision through the fascia along the lower margin of the muscle, from the twelfth thoracic spine to the spine of the scapula, and clean the muscle, from below upwards, to the level of the seventh cervical vertebra.

As the deep fascia is removed from the trapezius—and indeed throughout the whole dissection of the back—the cutaneous nerves must be carefully preserved, in order that the dissector of the Head and Neck may have an opportunity of establishing their continuity with the trunks from which they arise.

Trapezius.—The trapezius is a flat, triangular muscle which lies, in its entire extent, immediately subjacent to the deep fascia. It has a very long origin which extends, along the median plane, from the occiput above to the level of the last thoracic vertebra below. It arises from—(1) the medial third of the superior nuchal line and from the external occipital

protuberance ; (2) the ligamentum nuchæ and the spine of the seventh cervical vertebra ; (3) the tips of the spines of all the thoracic vertebræ, as well as the supraspinous ligaments, which bridge across the intervals between them (Fig. 23).

In the lower cervical and upper thoracic regions the tendinous fibres by which the two muscles arise lengthen out to form a flat tendon which is oval or diamond-shaped in outline.

As the fibres of the trapezius pass laterally they converge upon their insertions into the two bones of the shoulder girdle. The *occipital* and *upper cervical fibres* incline downwards, and, turning forwards over the shoulder, are inserted into the lateral third of the clavicle (Fig. 24) ; the *lower cervical* and *upper thoracic fibres* pass more or less transversely to gain an insertion into the acromion and the crest of the spine of the

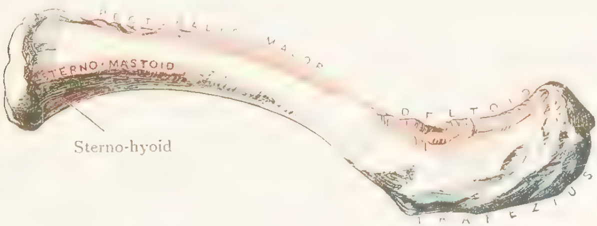


FIG. 24.—Upper Surface of the Right Clavicle.

scapula ; while the *lower thoracic fibres* are directed upwards, and, at the medial border of the scapula, end in a flat, triangular tendon, which plays over the smooth surface at the end of the scapular spine, and is inserted into a rough tubercle on the crest immediately beyond that surface (Fig. 35, p. 97). To facilitate the movement of the tendon upon the bone, a small synovial bursa is interposed between them.

The trapezius is supplied by the *accessory nerve* and by twigs from the *third* and *fourth cervical nerves.* It is an elevator and depressor of the shoulder ; and a rotator and adductor of the scapula.

Dissection.—The latissimus dorsi is now to be dissected. It is a difficult muscle to clean, not only on account of the varying direction of its fibres, but also because its upper part is generally very thin, and its upper border ill-defined.

Put the muscle on the stretch by folding the arm under the neck. Remove the superficial fascia and the deep fascia at the same time from its surface.

On the *right side*, cut through the fascia along the upper border of the muscle from the point where that margin disappears under the trapezius to the posterior fold of the axilla, and work downwards. On the *left side*, cut through the fascia from the iliac crest to the posterior fold of the axilla, and work medially and upwards.

Define carefully the attachment of the muscle to the lumbar fascia, and clean that fascia. Next, define the attachment of the muscle to the iliac crest; and when the lower part of the lateral

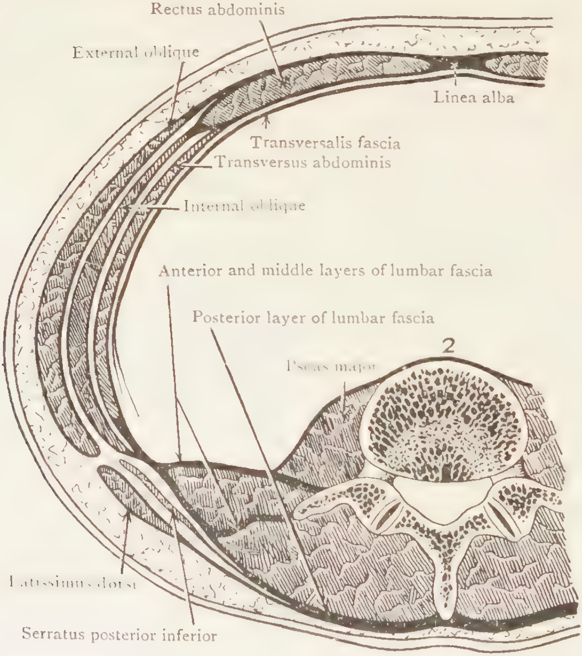


FIG. 25.—Diagram of the Lumbar Fascia.

border of the latissimus is reached, clean the slips attached to the lowest three or four ribs, and clean also the slips of the external oblique muscle of the abdomen which interdigitate with the costal slips of the latissimus dorsi.

Evert the upper margin of the muscle as it crosses the inferior angle of the scapula, and display the slip which springs from that angle. This scapular slip is liable to be mistaken for a piece of the teres major, upon which it lies.

Latissimus Dorsi. The latissimus dorsi is a wide, thin muscle which covers the back from the level of the sixth

thoracic vertebra down to the iliac crest (Fig. 23, p. 59). The greater part of it is subcutaneous; but its upper part, near the spines, is under cover of the trapezius. It arises—(1) from the tips of the lower six thoracic spines and the corresponding supraspinous ligaments; (2) from the superficial lamella of the lumbar fascia (Fig. 25); (3) from the outer lip of the iliac crest, in front of the lumbar fascia (Fig. 23); (4) from the lower three or four ribs; and (5) by a fleshy slip from the back of the inferior angle of the scapula (Fig. 35, p. 97).

Its fibres converge rapidly towards the lower part of the scapula. As a result of the convergence, the muscle is greatly reduced in width; and it sweeps over the inferior angle of the scapula in the form of a thick, fleshy band, which winds round the lower margin of the teres major muscle and terminates in a narrow, flat tendon, which is inserted into the floor of the bicipital groove of the humerus (Fig. 41). The insertion cannot be studied at present, but will be seen later (p. 99).

With the teres major muscle, the latissimus dorsi forms the posterior fold of the axilla. At first it is placed behind the teres major, then it is folded round its lower border, and finally it is inserted in front of it. To the peculiar relationship of the two muscles is due the full, rounded appearance of the posterior axillary fold. Near their insertion the two tendons are more or less adherent to each other, but are sometimes partly separated by a small bursa near the humerus.

The latissimus dorsi is supplied by a special nerve from the posterior cord of the brachial plexus. It is an adductor, retractor, and medial rotator of the upper limb.

Two Intermuscular Spaces. (1) A triangular space bounded by the trapezius, the latissimus dorsi, and the scapula, should now be noticed (Fig. 23, p. 59). Within the triangle, a small portion of the rhomboideus major muscle can be seen, and also a varying amount of the wall of the thorax—the borders of the sixth and seventh ribs and the space between them. This is the only part of the back of the thorax which is not covered with muscles. (2) Between the latissimus dorsi and the external oblique muscle of the abdomen, immediately above the iliac crest, there is sometimes a narrow interval, called the *lumbar triangle* (Fig. 23, p. 59), which will be examined by the dissector of the abdomen.

Dissection.—Reflexion of the Trapezius.—On the *second day*, begin by reflecting the trapezius, working, if possible, with the dissector of the Head and Neck. Divide the muscle about two inches from the spines of the vertebræ, and throw it towards its insertion. The trapezius is very thin at its origin, and, therefore, take great care not to injure the subjacent rhomboid muscles. Clean and preserve the vessels and nerves on the deep surface of the muscle; and look for the small bursa that lies between its tendon and the medial end of the spine of the scapula.

Nerves and Vessels of the Trapezius.—A dissection of the deep surface of the reflected muscle will reveal its vessels and nerves. They are :—

a. The accessory nerve.
b. Two or three nerves from the cervical plexus.
c. The superficial branch of the transverse cervical artery and twigs from its deep branch.

The dissector of the Head and Neck has already displayed the nerves as they cross the posterior triangle of the neck. The branches from the cervical plexus come from the *third* and *fourth cervical nerves*. On the deep surface of the trapezius they join with branches of the accessory nerve to form a plexus from which twigs proceed into the muscle. The terminal twig of the *accessory nerve* can be traced nearly to the lower end of the trapezius.

The *superficial branch of the transverse cervical artery* springs from that artery at the upper or anterior border of the trapezius, and accompanies the accessory nerve. The *twigs from the deep branch of the transverse cervical artery* pierce the levator scapulæ and the rhomboid muscles, or pass between them, close to the medial border of the scapula.

Dissection. The inferior belly of the omo-hyoid and the suprascapular artery and nerve must now be displayed, and the insertion of the trapezius examined. Divide the trapezius by a transverse cut at the level of the angle between the clavicle and the spine of the scapula, and examine the insertion of the muscle. Next, clean away the fat in the area exposed, and display the *inferior belly of the omo-hyoid muscle*, the *suprascapular vessels* and *nerve*, and the fascia over the supraspinatus. The supraspinatus covers the scapula between the spine and the upper border of the bone. The inferior belly of the omo-hyoid is attached to the lateral part of the upper border; follow it upwards into the neck. The suprascapular artery crosses the suprascapular ligament just lateral to the omo-hyoid, and the suprascapular nerve is below the ligament; clean the parts of them seen now.

The next step is to define the muscles that connect the medial margin of the scapula to the vertebral column. From above downwards, they are (1) the *levator scapulæ*, (2) the *rhomboideus*

minor, (3) the *rhomboideus major*. Clean their surfaces, having put them on the stretch by drawing the scapula well over the edge of the block that supports the thorax.

Omo-hyoideus.—This muscle stretches from the scapula to the hyoid bone, and has two slender bellies united by an intervening tendon. The *inferior belly* arises from the suprascapular ligament and the upper border of the scapula, and passes upwards and forwards into the neck to join the tendon.

Levator Scapulæ.—This thick, elongated muscle arises by slips from the transverse processes of the upper four cervical vertebræ. It passes downwards and backwards to be inserted into the medial margin of the scapula, from the upper angle to the spine. It is supplied by the *nerve to the rhomboids* and by branches from the *third* and *fourth cervical nerves*.

Rhomboid Muscles.—The two rhomboid muscles constitute a thin, quadrangular sheet of muscular fibres which extends from the spines of the vertebræ to the medial margin of the scapula. They are supplied by a special branch (*nerve to the rhomboids*) from the fifth cervical nerve. They pull the scapula upwards and backwards, and help to rotate it.

The **rhomboideus minor** is a narrow, ribbon-like band which runs parallel to the upper border of the major rhomboid. It springs from the ligamentum nuchæ and the spine of the seventh cervical vertebra. It is inserted into the medial margin of the scapula opposite its spine (Fig. 35, p. 97). It is entirely covered by the trapezius.

The **rhomboideus major** arises from the upper four or five thoracic spines, and the corresponding supraspinous ligaments. Its fibres run obliquely downwards and laterally, and end in a tendinous arch which is attached to the medial margin of the scapula, from the inferior angle to the spine (Fig. 35, p. 97). The greater part of the rhomboideus major is covered by the trapezius; only a small portion near the inferior angle of the scapula lies immediately subjacent to the deep fascia.

Dissection.—Clean the *levator scapulæ*, taking care not to injure its nerves. The muscle belongs partly to the dissector of the Head and Neck and partly to the dissector of the Upper Limb. When both of them have studied its attachments and nerve-supply, divide the muscle across its middle; turn the lower half towards its insertion. Secure the *nerve to the rhomboids* and the *deep branch of the transverse cervical artery*, which lie deep to the muscle, and follow them to the rhomboideus minor.

Next, cut through the rhomboids midway between the scapula

and the spines of the vertebræ ; remember that they are very thin, and take care not to injure a thin muscle, called the *serratus posterior superior*, which is immediately subjacent to them. Turn the medial part of each muscle towards the vertebral spines, and verify its attachment. Turn the lateral parts towards the scapula, and follow the nerve to the rhomboids and the deep branch of the transverse cervical artery to their terminations.

The **nerve to the rhomboids** is a long, slender nerve that arises from the fifth cervical nerve, usually in common with the upper root of the nerve to the serratus anterior. It passes downwards and laterally to reach the levator scapulæ, and descends under cover of the levator and the rhomboids, near the scapula. It supplies one or two twigs to the levator scapulæ and ends in the rhomboids.

The **deep branch of the transverse cervical artery** takes origin in the lower part of the neck close to the lateral or anterior margin of the levator scapulæ. It descends under cover of the levator scapulæ and the two rhomboids, near the medial border of the scapula (Fig. 23, p. 50), giving numerous branches to surrounding muscles.

Dissection. Divide the latissimus dorsi. Begin at the upper border three inches from the vertebral spines, and carry the knife to a point just below the origin of the muscle from the last rib. Remember that the muscle is thin, and do not injure the parts subjacent to it. Turn the medial portion towards the vertebral spines – taking special care not to injure a thin muscle, called the *serratus posterior inferior*, which lies in the region of the lower four ribs and verify the origin of the latissimus (p. 63). Throw the lateral part of the muscle laterally and forwards ; and, at the inferior angle of the scapula, find its nerve of supply.

Removal of Upper Limb. (1) Divide the suprascapular artery and nerve and the inferior belly of the omo-hyoid at the upper border of the scapula.

(2) Divide the nerve to the rhomboids and the deep branch of the transverse cervical artery near the upper angle of the scapula.

(3) Pull the medial border of the scapula away from the ribs to expose the posterior part of the serratus anterior.

(4) Cut through the posterior part of the serratus anterior about one inch from the medial margin of the scapula.

(5) Pull the scapula still farther away from the thorax, and divide the axillary vessels and the brachial plexus at the outer border of the first rib.

(6) Detach the anterior skin flap previously stitched to the anterior wall of the thorax, and take the limb to the table provided, where the further dissection is to be completed.

FREE UPPER LIMB.

Dissection.—Separate the divided axillary vessels and the cords of the brachial plexus from one another, and tie them to a piece of wood, two or three inches long, *in their proper relative positions*; and then, by means of a loop, fix the wood to the coracoid process. In this way, the vessels and nerves will be retained in their proper relationships during the further stages of dissection; and they can be released from the coracoid process when it is necessary to examine anything which lies behind them.

After the limb has been detached, the dissector will remove the skin from it; but, before doing so, he will study the surface anatomy.

Surface Anatomy. Place the fingers on the lateral side of the arm just below the acromion, and move the arm in any direction. The upper end of the humerus is felt moving under cover of the deltoid muscle; the part of it felt is the **greater tuberosity** (Figs. 2, 48, 50); the **lesser tuberosity** is felt on the front. Follow the shaft downwards, squeezing the soft parts between finger and thumb. About half way down on the lateral side, the **deltoid tuberosity** can be felt—rather indistinctly. Move the fingers backwards and forwards immediately below and behind the tuberosity: a large nerve, called the **radial nerve**, can usually be felt between the finger and the bone, though the nerve is covered with muscle. As the elbow is approached, the humerus widens from side to side, and acquires fairly sharp margins called the **lateral** and **medial supracondylar ridges**; the lateral ridge is the more outstanding and the more easily felt. The ridges end in projections called the epicondyles of the humerus. The **lateral epicondyle** is not prominent, but is easily felt in the upper part of a shallow depression on the back of the limb. The **medial epicondyle** is prominent. It can be seen as well as felt. Grip it between finger and thumb. Note that it inclines slightly backwards. Press the finger on the back of it, and move the finger from side to side: the **ulnar nerve** is felt between the finger and the bone. When the arm hangs by the side, the medial epicondyle fits into the curve of the waist. With the palm looking forwards, the epicondyles occupy the relative position indicated by their names (lateral and medial); when the limb hangs comfortably, with the palm looking towards the thigh, the humerus is then so placed that the lateral

epicondyle is well round at the front. and the medial epicondyle at the back.

The fleshy, bulging mass on the front of the upper arm is composed chiefly of the **biceps brachii.** Place your fingers on the medial margin of the biceps near the elbow, push the biceps away, press the fingers backwards and move them from side to side : the cord felt is the **median nerve** ; and,

FIG. 26.—Relation of Bones of Elbow to the surface. Dorsal view ; elbow fully extended.

FIG. 27. — Relation of the Bones of the Elbow to the surface. Dorsal view ; elbow bent.

in the living limb, the pulsations of the **brachial artery** are felt. On each side of the biceps there is a faint, shallow groove. The vein seen through the skin on the surface of the biceps, in front of the lateral groove, is called the **cephalic vein.** The vein seen in the medial groove is called the **basilic vein.** At the upper part of the medial groove there is a narrow, fleshy ridge produced by the **coraco-brachialis muscle** ; the lower part of the **axillary artery** and the upper part of the **brachial artery** lie close behind and medial to the ridge, and can be seen beating in the living limb. The **tendon of insertion of the**

biceps is readily felt in the middle of the front of the elbow when the elbow is bent.

The **coronoid process** of the ulna is hidden under muscles ; but the tubercle on its medial margin can be felt about an inch below the medial epicondyle, and the **ulnar nerve** can be felt crossing the tubercle. The **olecranon** of the ulna is the bony prominence at the back of the elbow ; the skin moves freely over the back of it, because a bursa is placed between them. Note the relative positions of the olecranon and the epicondyles during the movements of the elbow (Figs. 26, 27, 84). It is by a knowledge of their normal relative positions that the surgeon can distinguish among the different forms of fracture and dislocation that occur so often in the elbow region. When the elbow is straightened out to its full extent, the three prominences lie in the same horizontal plane ; when it is bent to a right angle, they are at the angles of a triangle that is nearly equilateral.

The **posterior border of the ulna** is subcutaneous from end to end, and can be felt as a sharp edge that runs downwards from the olecranon. It ends at the styloid process of the ulna (Figs. 2, 3, 70, 75). The **styloid process** makes a blunt ridge on the medial side where the forearm joins the wrist. When the palm faces forwards or upwards, the process is seen and felt at the medial margin of the back of the forearm ; when the palm faces backwards or downwards, the process is on the medial surface of the forearm, and, in its place on the back, there appears a smooth, rounded prominence which is the **head of the ulna**. The distal third of the medial surface of the shaft of the ulna also is subcutaneous and easily felt.

The **head of the radius** lies below the lateral epicondyle, in the lower part of the depression on the back of the limb. Place your finger tip in the depression and feel the transverse groove between the humerus and the head of the radius; rotate the hand backwards and forwards: the head of the radius can be felt rotating, though it is covered by a strong ligament called the **annular ligament**. The **shaft of the radius** is buried among muscles, but can be felt through them. The **distal end of the radius** is a block of bone that can be felt at the distal end of the forearm, on both back and front and also on the lateral side. Feel for its **dorsal tubercle** on the back towards the lateral side. When the living thumb is bent

backwards, a hollow appears between the tendons on the lateral side of the wrist. The hollow is called the "anatomical snuff-box"; and the **styloid process of the radius** is the bone felt in the upper part of its floor.

Now, examine the palm of your own hand. The **hypothenar eminence** or ball of the little finger is the smooth, soft elevation along the medial side of the hollow of the palm. It overlies the fifth metacarpal bone, and is composed of the short muscles of the little finger. Feel the **pisiform bone** at the upper end of the eminence. Grip the pisiform bone between finger and thumb, and note that it can be moved slightly on the **triquetrum,** which is the bone concealed behind the pisiform; then move your thumb towards the centre of the palm for an inch, and press backwards firmly. The bony resistance felt is given by the **hook of the hamate bone.** Move the thumb from side to side, and feel the superficial terminal branch of the **ulnar nerve** rolling over the hook.

The **thenar eminence** or ball of the thumb is the ovoid, fleshy elevation that forms the supero lateral boundary of the hollow of the palm. It overlies the first metacarpal bone, and is composed of three of the small muscles of the thumb. The tendons of two muscles, called the *flexor carpi radialis* and the *palmaris longus*, are seen descending side by side in the middle of the forearm towards the wrist. The flexor carpi radialis is the more lateral of the two, and it disappears at the upper medial part of the thenar eminence. Place your finger in the angle between the eminence and the tendon. The bone felt there is the **tubercle of the scaphoid.** The **crest of the trapezium** is the bone felt indistinctly in the thenar eminence, just distal to the tubercle. The *skin crease* that runs across the front of the limb at the level of the uppermost parts of the pisiform and the tubercle of the scaphoid marks the junction of the forearm and the wrist, and marks also the position of the upper border of a very strong ligament called the **flexor retinaculum.**

Several creases traverse the skin of the palm, but are of no service as landmarks. Three of them are fairly constant in position. The *upper one* begins at the tubercle of the scaphoid, curves round the thenar eminence, and ends at the lateral margin of the hand. The *middle one* begins where the first one ends, runs nearly transversely across the palm, and fades away near the hypothenar eminence. The *lower one*

begins near the cleft between the forefinger and middle finger, and runs, with a slight curve, to the medial margin of the hand (Fig. 68).

The distal boundary of the hollow of the palm is a low, uneven elevation that overlies the **metacarpo-phalangeal joints** of the four fingers. The creases at the root of a finger are about an inch (25 mm.) distal to the metacarpo-phalangeal joint. The upper of the two (or more) creases at the middle of a finger is opposite the first **interphalangeal joint**; but at the second joint the creases are proximal to the joint.

On the lateral surface of the wrist, the **scaphoid** and the **trapezium** lie in the floor of the "snuff-box," between the styloid process of the radius and the first metacarpal, and can be felt if the hand is bent towards the medial side. On the medial surface, the **triquetrum** is easily felt, behind the pisiform; the *dorsal branch of the ulnar nerve* can be rolled between the finger and the triquetrum; the triquetrum overlaps the hamate bone so that the hamate bone can scarcely be felt on the medial side.

On the back of the hand, the **carpal bones** are hidden by the extensor tendons as they pass off the radius and ulna; these tendons ridge the skin when the fingers are extended. The **metacarpal bones** can all be felt through the tendons. The muscles between them are the *dorsal interossei*, of which the first is the largest and the only one visible in the living hand; it can be seen and felt contracting if you bend the forefinger or abduct it from the others. The *bases* or proximal ends of the metacarpal bones form small uneven prominences about an inch below the radius and ulna. Their distal ends or *heads* are the first row of **knuckles.** The **metacarpo-phalangeal joints** are distal to the knuckles. The *heads* of the **phalanges** are the second and third rows of knuckles, and the **interphalangeal joints** are immediately distal to them.

Superficial Structures.

The whole of the skin should now be removed from the limb while the subcutaneous tissues are still in good condition, and in order that a general view of the cutaneous veins and nerves may be obtained. The main cutaneous veins carry blood to the axillary vein; the cutaneous nerves are either

direct branches of the brachial plexus or they spring from the main terminal branches of the plexus.

Dissection.—(1) Place the limb on its back; (2) make an incision along the front of the limb from the region already denuded to the tip of the middle finger (Fig. 4); (3) make a transverse incision at the wrist; (4) a transverse incision at the proximal ends of the fingers; (5) an oblique incision from the middle of wrist to the tip of the thumb; (6) incisions along the middle of the index, the ring finger, and the little finger.

Next, remove the flaps, taking great care not to injure the cutaneous vessels and nerves. Reflect the flaps to the margins of the limb and the margins of the digits, and then dissect them from the back of the limb, including the digits.

When the skin is completely removed it must not be thrown away but must be kept to be wrapped round the part when the dissection is not proceeding.

Superficial Fascia.—The superficial fascia presents no peculiarities in the upper arm, the forearm and the back of the hand; the amount of fat in it varies considerably in different subjects; and the dissector will have found that the skin is readily separated from it, except over the epicondyles and the olecranon. In the palm and on the front of the digits, the superficial fascia is dense, and is adherent to the skin, for there the skin is bound to the deep fascia by fibrous septa which pass through the superficial fascia dividing it into small loculi occupied by separate lobules of fat. In the medial part of the palm, about an inch below the creases at the wrist, some muscle fibres will be brought into view; they connect the skin on the medial margin of the palm with the deep fascia of the middle of the palm, and constitute the *palmaris brevis muscle*. A loose, slender band of fibres, called the *superficial transverse ligament of the palm*, lies in the superficial fascia across the roots of the fingers and in the webs between them. When the hand is put into the position in which it grasps a spherical object, this ligament is put on the stretch and the palmaris brevis contracts, and they thus assist in deepening the "cup" of the palm.

Cutaneous Veins. The cutaneous veins should be dissected first, because they are, except here and there, the most superficial structures (Figs. 28, 31).

Dissection.—Be careful to preserve any nerves met with as the veins are being cleaned. Begin at the interval between the pectoralis major and the deltoid, and follow the cephalic vein downwards, being careful to preserve the tributaries which join it. At the bend of the elbow secure and clean a large

communicating branch, called the *median cubital vein*, which runs obliquely upwards to join the *basilic vein*. Secure also a vein which pierces the deep fascia and connects the median cubital vein with the deep veins of the forearm.

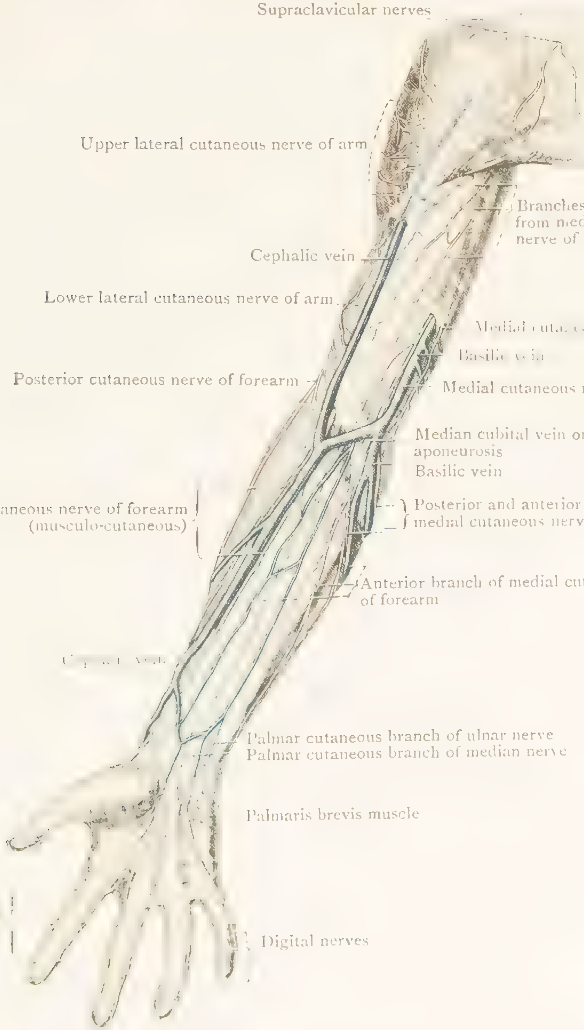


FIG. 28.—Superficial Veins and Nerves of the Front of the Upper Limb.

Follow the cephalic vein down the forearm and round its radial margin to its origin from the *dorsal venous arch*. Trace the dorsal venous arch across the back of the hand, from the radial to the ulnar side, where the *basilic vein* arises from it. Follow the basilic vein upwards along the ulnar border of the forearm, and then upwards in front of the medial epicondyle, and onwards to the middle of the upper arm where it pierces the deep fascia. As you clean it, look for the *supra-trochlear lymph glands* which lie in the superficial fascia a little above the medial epicondyle.

Return to the dorsal venous arch and clean its tributaries.

The superficial veins must now be studied.

The **dorsal venous arch** usually lies across the lower part of the back of the hand; but it is inconstant in position and shape, as the dissectors may see if they compare their own hands. It gives origin to the basilic and cephalic veins; and it receives numerous tributaries, including the three *dorsal metacarpal veins*, which lie in the spaces between the metacarpal bones of the fingers.

Two *dorsal digital veins* lie along the margins of the back of each digit, and are connected by *venous arches*. The dorsal digital veins of the thumb join the cephalic vein; the radial one of the index joins the dorsal venous arch; the ulnar one of the little finger joins the basilic vein; the others end in the dorsal metacarpal veins.

Communicating veins that pass through the intermetacarpal spaces connect the veins of the back of the hand with the veins of the palm.

The **cephalic vein** commences at the radial end of the dorsal venous arch. It receives the two dorsal digital veins from the thumb, and then turns round the radial border of the distal part of the forearm and ascends to the front of the elbow; there the greater part of its blood is transmitted to the basilic vein by the median cubital vein. It then ascends along the lateral surface of the biceps to the lower border of the pectoralis major; there it pierces the deep fascia (Fig. 28), and proceeds upwards in the groove between the pectoralis major and the deltoid to the infraclavicular fossa. In that fossa it crosses the lateral part of the pectoralis minor, and turns medially between the clavicular part of the pectoralis major and the clavi-pectoral fascia. In this terminal part of its course it lies anterior to the axillary artery, but is separated from the artery by the clavi-pectoral fascia. Finally, it pierces that fascia and joins the axillary vein.

It receives (1) the dorsal digital veins of the thumb, (2) tributaries of varying size and number in the forearm and upper arm, and (3), immediately before it pierces the clavi-pectoral fascia, it is joined by the venæ comitantes of branches of the acromio-thoracic artery.

The **basilic vein** begins at the medial end of the dorsal venous arch. It receives the dorsal digital vein from the medial side of the little finger, and then ascends along the medial surface of the forearm—often as two channels which unite before they reach the elbow. Near the elbow, it inclines forwards to ascend in front of the medial epicondyle. An inch or more above the medial epicondyle, it is joined by the median cubital vein. It then runs along the medial margin of the biceps to the middle of the upper arm, where it pierces the deep fascia, opposite the insertion of the coraco brachialis. After it has pierced the deep fascia, it runs along the medial side of the brachial artery to the lower border of the teres major, where it becomes the axillary vein. Only the termination of this, upper, part of the vein can be seen at present; the remainder will be displayed in a later dissection.

The tributaries of the basilic vein are (1) the medial dorsal digital vein of the little finger, (2) tributaries of varying size and number in the forearm and upper arm, (3) the median cubital vein.

The **median cubital vein** is a large communicating vein which springs from the cephalic vein about an inch below the bend of the elbow, and runs obliquely up to join the basilic vein about an inch above the medial epicondyle. As it crosses from the cephalic to the basilic vein, it receives tributaries from the front of the forearm, is connected with the deep veins, is separated from the distal part of the brachial artery by a portion of deep fascia thickened by an expansion from the biceps tendon called the *bicipital aponeurosis*, and is crossed either deeply or superficially by the anterior branch of the medial cutaneous nerve of the forearm (Fig. 28).

The Lymph Vessels and Lymph Glands of the Upper Limb. In an ordinary dissecting-room part, it is impossible to display the lymph vessels of the limb in a satisfactory manner. The dissector will have seen some of the axillary glands, and may have found a supratrochlear and possibly a delto-pectoral gland. But he will not have been able to trace the lymph vessels except for short distances near those glands.

At this stage it is, however, worth his while to review the general arrangement of lymph vessels and glands in the limb.

As in other parts of the body, both the vessels and the glands are arranged in two main groups—superficial and deep.

The **superficial lymph glands** are (1) the delto-pectoral glands (p. 30), and (2) the ***supra-trochlear glands***, which are two small glands that lie a little above the medial epicondyle near the medial side of the basilic vein, and are liable to become inflamed and painful when wounds of the ulnar border of the hand fester.

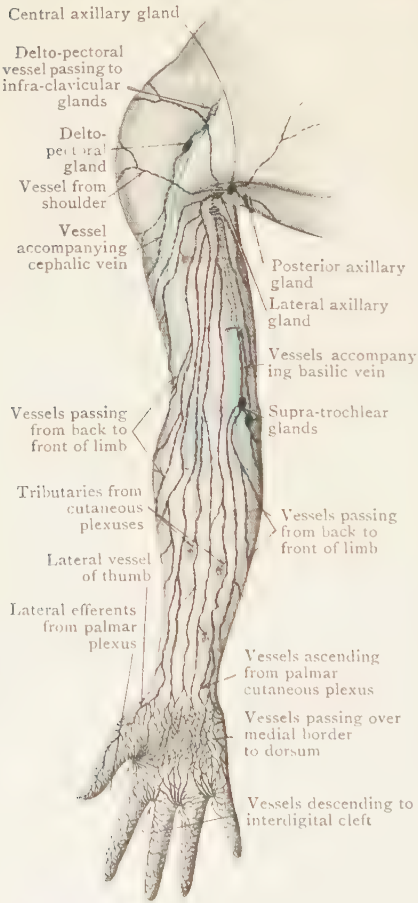


FIG. 29.—Superficial Lymph Vessels and Lymph Glands of front of Upper Limb.

The **deep lymph glands** lie along the course of the main blood-vessels. The chief groups are in the axilla, but in addition to them there are a few along the medial side of the brachial artery and at its bifurcation. Occasionally, small glands are found in relation to the radial, ulnar, and interosseous arteries.

The **deep lymph vessels** receive the lymph from all the structures that are deep to the deep fascia, but they are much less numerous than the superficial vessels. They accompany the main blood-vessels and end in the glands alongside the axillary vessels—some of them being interrupted in the glands related to the brachial artery.

The **superficial lymph vessels** collect the lymph from the skin and the subcutaneous tissues, and they also ultimately reach the glands in the axilla. The paths which they take are determined by the main trend of the stream: (*a*) as the vessels begin to run up the forearm from the hand, most of them run towards the back of the wrist rather than the front; (*b*) in their course towards the axilla, all these vessels and most of those which arise in the forearm and upper arm come to the medial side of the front of the upper arm and run along the line of the basilic vein (Figs. 29, 30).

As the lymph vessels of the front of the digits ascend, they curve round the sides to join those on the back. In the palm of the hand there is a dense cutaneous network of lymph capillaries from which the lymph vessels arise. Those of the vessels that run upwards over the front of the wrist are only the few that arise from the proximal margin of the plexus. Those from the distal margin descend to the interdigital clefts and join the vessels of the fingers. Others arise in the lateral and medial margins of the plexus and curve over the borders of the hand on to the back, where they are joined by the vessels from the fingers. All of the vessels of the fingers and most of the vessels of the palm therefore ascend across the back of the wrist. In their further ascent, they gradually curve round the borders of the forearm, and sweep up the medial side of the front of the upper arm, to end in the glands alongside the axillary vessels. One or two vessels from the ulnar border of the hand end in the supratrochlear glands; the efferent vessels of those glands, together with a few other vessels, pierce the deep fascia with the basilic vein and accompany it to the axilla; the remaining vessels do not pierce the deep fascia till they reach the axilla. One or two lymph vessels from the lateral side of the forearm and upper arm leave the main stream and accompany the cephalic vein either to end in the delto-pectoral glands or to proceed direct to the infraclavicular glands. The lymph vessels of the deltoid region run an independent course to the glands in the axilla—some of them crossing the delto-pectoral groove before they pierce the deep fascia.

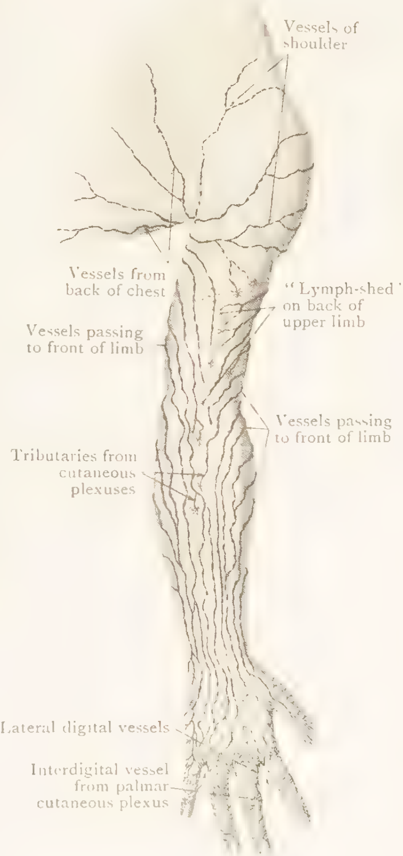
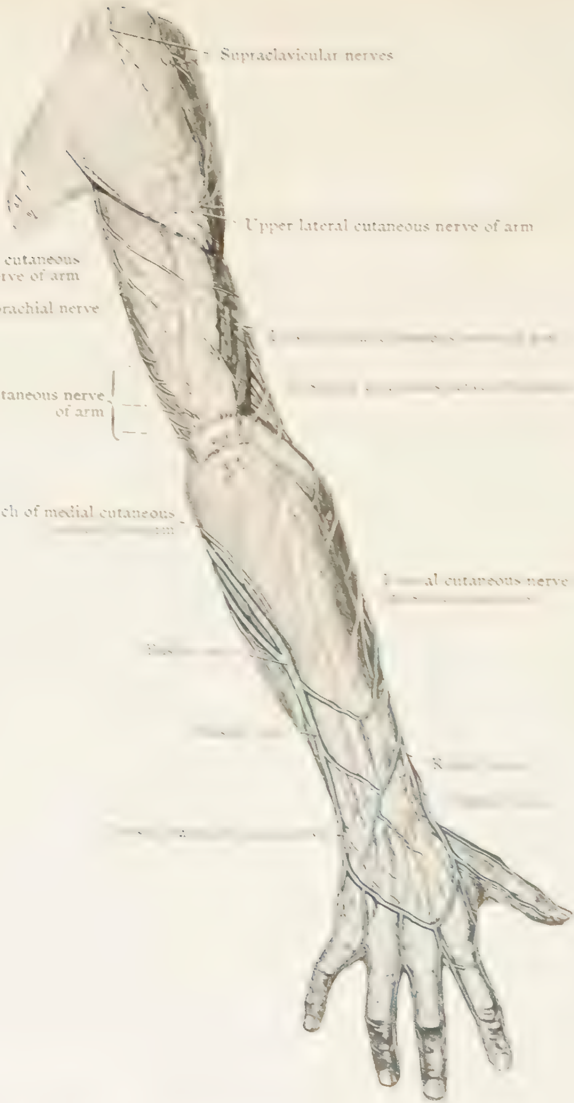


FIG. 30.—Superficial Lymph Vessels of back of Upper Limb.

The superficial lymph vessels, as they traverse the limb, anastomose


Supraclavicular nerves
Upper lateral cutaneous nerve of arm
Posterior cutaneous nerve of arm
Intercosto-brachial nerve
Medial cutaneous nerve of arm
Posterior branch of medial cutaneous
al cutaneous nerve of forearm

with one another to some extent, but each retains a definite individuality throughout its course.

The glands in the axilla drain a wide territory apart from the free upper limb:—the pectoral region and the abdominal wall down to the level of the umbilicus, the side of the chest, the scapular region and the back down to the iliac crest. The regions above that territory are drained into the lymph glands of the neck, and the regions below into the glands of the groin—to which also there is a convergence of superficial lymph vessels from a wide area.

The student should compare the arrangement of the superficial lymph vessels of the Upper and Lower Limbs (cf. Figs. 29, 30, and Figs. 151-2). They begin in a similar manner in the hand and in the foot; and, in each limb, two streams are formed—a chief and a subsidiary—each associated with a vein. The chief stream in the lower limb follows the long saphenous vein to the glands in the groin, which, though mainly superficial, correspond to the glands in the axilla. The subsidiary stream in the lower limb follows the short saphenous vein to the glands in the popliteal fossa. These popliteal glands correspond to the glands at the bifurcation of the brachial artery *plus* the supratrochlear glands; the lymph vessels that follow the short saphenous vein correspond therefore to those of the upper limb that pierce the deep fascia with the basilic vein.

Cutaneous Nerves of Upper Arm and Forearm.

When the superficial veins and their connexions have been cleaned and studied, the cutaneous nerves of the upper arm and the forearm must be found and cleaned (Figs. 28, 31). They are:—

Lateral supraclavicular nerves. Intercosto-brachial nerve. Medial cutaneous nerve of the arm. Upper lateral cutaneous nerve of the arm. Posterior cutaneous nerve of the arm Lower lateral cutaneous nerve of the arm.	To the skin of the upper arm.
7. Medial cutaneous nerve of the forearm. Posterior cutaneous nerve of the forearm.	To the skin of the … arm and the forearm.
9. Lateral cutaneous nerve of the forearm.	To the skin of the forearm and ball of the thumb.

Dissection.—Turn to the proximal end of the limb and find the cutaneous nerves that were severed when the limb was removed from the trunk, namely—the intercosto-brachial, the medial cutaneous nerves of the arm and forearm, and the lateral supraclavicular nerves (Figs. 5, 31).

Begin with the *intercosto-brachial nerve*. Trace it downwards through the medial side of the upper arm.

Find, next, the *medial cutaneous nerve of the arm*. Pull on it gently. Note that it does not pierce the deep fascia till it is near the middle of the upper arm. From that point, trace it downwards, in front of the intercosto-brachial, as far as the elbow.

The *medial cutaneous nerve of the forearm* is thicker than either

of the preceding nerves. Pull on it also. It does not pierce the deep fascia till it reaches the middle of the upper arm. Look for small branches that pierce the deep fascia above that level. Secure the nerve where it pierces the deep fascia, and follow it downwards. Near the elbow, it divides into two branches. Trace them downwards through the fat on the medial side of the forearm to their terminations at the wrist.

Look for the remains of the *lateral supraclavicular nerves*, and trace them through the fat over the upper half of the deltoid.

Identify the *posterior cutaneous nerve of the arm*, which springs from the radial nerve in the axilla. Trace it downwards through the fat of the back of the upper arm.

Next, examine the back of the scapular region and locate the posterior border of the deltoid muscle. Make an incision through the fascia along the lower half of that border, and secure the *upper lateral cutaneous nerve of the arm* (a branch of the circumflex); trace its branches through the fascia over the lower half of the deltoid (Figs. 28, 31).

Now, look for the *lower lateral cutaneous nerve of the arm*. It is often difficult to find it. It pierces the deep fascia about an inch below the insertion of the deltoid. Trace it downwards through the lateral part of the front of the upper arm. The *posterior cutaneous nerve of the forearm* pierces the deep fascia about two inches below the deltoid tuberosity. Follow it downwards behind the lateral epicondyle, and along the back of the forearm. The origins of these two branches of the radial nerve cannot be seen at present; they will be displayed when the back of the upper arm is dissected.

Turn to the front of the limb again, and find the *lateral cutaneous nerve of the forearm*. It appears at the lateral border of the biceps, under cover of the cephalic vein about an inch above the bend of the elbow, and soon divides into two branches; trace them along the lateral side of the forearm to the hand.

Before proceeding to examine the cutaneous nerves of the hand, the dissector should study the position and distribution of the cutaneous nerves of the upper arm and of the forearm, all of which he has now displayed.

The lateral supraclavicular nerves are derived from the fourth cervical nerve. They cross the lateral third of the clavicle and the insertion of the trapezius, under cover of the platysma, and diverge from one another to supply the skin over the upper half of the deltoid.

The upper lateral cutaneous nerve of the arm derives its fibres from the fifth and sixth cervical nerves. It springs from the circumflex (axillary) nerve under cover of the posterior border of the deltoid muscle; curving round that border at the junction of its lower and middle thirds, it runs forwards, dividing into diverging branches, and supplies the skin over the lower half of the deltoid.

The skin over the deltoid is supplied also by several fine

filaments that spring from the circumflex nerve as it courses forwards under cover of the deltoid; they pierce the muscle at irregular intervals, and are so slender that it is difficult to find them.

The **medial cutaneous nerve of the arm** derives its fibres from the eighth cervical and first thoracic nerves. It springs from the medial cord of the brachial plexus; descends along the medial side of the axillary vein and of the basilic vein; pierces the deep fascia near the middle of the upper arm, and supplies the skin on the medial side of the lower half of the upper arm (behind the basilic vein) and the adjoining part of the back of the arm.

The **intercosto-brachial nerve** is the lateral cutaneous branch of the second intercostal nerve. It emerges from the second intercostal space, crosses the axilla near the skin of its floor, enters the upper arm, pierces the deep fascia about an inch below the posterior fold of the axilla, and descends almost to the olecranon. Its branches supply the skin of the floor of the axilla, the skin on the proximal part of the upper arm behind the brachial artery, and a variable area of skin on the back of the upper arm.

The **posterior cutaneous nerve of the arm** (fibres from fifth, sixth, seventh, eighth cervical) arises in the axilla from the radial nerve. It descends behind the radial nerve, pierces the deep fascia a little below the posterior fold of the axilla, and runs towards the olecranon. It supplies a wide area of skin on the back of the upper arm from the level of the deltoid tuberosity to the elbow.

The **lower lateral cutaneous nerve of the arm** (c. 5 and 6) is a branch of the radial nerve. It takes origin on the back of the limb, in the spiral groove, under cover of the lateral head of the triceps muscle. Passing downwards and forwards between the lateral and medial heads of the triceps (or through the lateral head), it pierces the deep fascia an inch below the deltoid tuberosity. It supplies the skin of the front of the upper arm, lateral to the cephalic vein, from the deltoid tuberosity to the elbow.

The **posterior cutaneous nerve of the forearm** (c. 5, 6, 7, 8) arises with the preceding nerve, and pierces the deep fascia an inch or less lower down. It passes downwards behind the lateral epicondyle, and descends through the fascia on the back of the forearm to the wrist. It gives a few

branches to the skin of the lateral part of upper arm, and supplies the skin of the middle of the back of the forearm from the elbow to the wrist.

The **lateral cutaneous nerve of the forearm** (c. 6) is the continuation of the musculo-cutaneous nerve. It pierces the deep fascia at the lateral side of the biceps, about an inch above the bend of the elbow, behind the cephalic vein. It soon divides into two branches—*anterior* and *posterior*—which run to the lateral side of the wrist. They supply the skin of the lateral side of the forearm both on the front and on the back; and the anterior branch supplies the skin of the upper part of the ball of the thumb.

The **medial cutaneous nerve of the forearm** (c. 8; T. 1) arises in the axilla from the medial cord of the brachial plexus. It runs downwards along the axillary and brachial arteries to the middle of the upper arm, where it pierces the deep fascia, opposite the insertion of the coraco-brachialis. At a varying point above the elbow, it divides into *anterior* and *posterior* branches, which descend along the medial side of the forearm to the wrist. As they enter the forearm, the anterior branch passes either behind or in front of the medial cubital vein, and the posterior branch passes either behind or in front of the medial epicondyle. Small branches supply the skin of the front of the upper arm between the basilic and cephalic veins; the uppermost of those branches arise above the middle of the upper arm, and pierce the deep fascia at the medial margin of the biceps. The terminal branches supply the skin of the medial half of the forearm.

Cutaneous Nerves of Hand.—After the dissector has reviewed the cutaneous nerves of the upper arm and forearm, he will proceed to dissect the cutaneous nerves of the hand.

1. Palmar cutaneous branch of median. 2. Palmar cutaneous branch of ulnar.	To skin of palm.
3. Digital branches of median. 4. Digital branches of ulnar. 5. Radial nerve at the hand, and its digital branches. 6. Dorsal branch of ulnar and its digital branches.	To skin of fingers and back of hand.

Dissection.—Place the limb on its back, and look for the palmar cutaneous branches of the median and ulnar nerves.

First, look for the tendons of the flexor carpi radialis and palmaris longus, lying side by side in the middle of the forearm above the wrist. The *palmar cutaneous branch of the median*

nerve pierces the deep fascia between those two tendons, or near them ; trace it to the middle of the palm. Next, find the tendon of the flexor carpi ulnaris, which descends to the pisiform bone. The *palmar cutaneous branch of the ulnar nerve* pierces the deep fascia near the lateral margin of that tendon ; trace it also into the palm.

Define the *superficial transverse ligament* (p. 72), and then remove the superficial fascia from the area between the ball of the thumb and the roots of the fingers in order to expose a thick sheet of deep fascia called the *palmar aponeurosis.*

Opposite the distal ends of the metacarpal bones, the palmar aponeurosis divides into slips—one for each finger. Look for the three *palmar digital nerves* between those slips. Divide the superficial transverse ligament in order to expose them more fully, and trace their branches along the sides of the fingers, cleaning also the digital arteries which accompany them. Find another digital nerve on the hypothenar eminence and trace it to the medial side of the little finger. Pass to the other border of the palm and find the digital branch for the radial side of the forefinger at the lateral margin of the slip of the aponeurosis for that finger, and trace the nerve onwards. Close to the thenar eminence, look for the two digital nerves of the thumb and follow them along the sides of the thumb. Careful dissection will show that some of the finer branches of the digital nerves end in minute, ovoid bodies called *lamellated corpuscles.*

Turn now to the back of the hand. Scrape away the fat on the medial side of the wrist below the styloid process of the ulna, and find the *dorsal branch of the ulnar nerve* ; trace its branches to the little finger and the ring finger. Next, pass to the lateral surface of the lower end of the radius ; find the *terminal part of the radial nerve*, and trace its branches to the back of the thumb, the forefinger, the middle finger, and the ring finger.

Having displayed the cutaneous nerves of the hand, the dissector will now study them more fully.

The upper part of the skin of the ball of the thumb is supplied by the terminal twigs of the anterior branch of the lateral cutaneous nerve of the forearm : the palmar digital nerves of the thumb supply the lower part. The rest of the skin of the palm is supplied by the palmar cutaneous branches of the median and ulnar nerves. At present, the dissector can see only the lower parts of these two nerves ; their upper parts will be seen when the deeper parts of the front of the forearm are dissected.

The **palmar cutaneous branch of the median nerve** (c. 6, 8) arises about an inch above the wrist, passes obliquely downwards behind the flexor carpi radialis tendon, pierces the deep fascia between that tendon and the tendon of the palmaris longus, and descends, branching, to supply the skin of the hollow of the palm.

The **palmar cutaneous branch of the ulnar nerve** (c. 8) is a very slender nerve that arises at a variable point below the middle of the forearm, runs downwards over the surface of the ulnar artery, pierces the deep fascia near the wrist, and descends to supply the skin of the medial third of the palm.

The **dorsal branch of the ulnar nerve** (c. 8) is larger. It also arises at a varying point below the middle of the forearm, and its origin will be examined later. It descends with the ulnar nerve, under cover of the flexor carpi ulnaris, almost to the pisiform bone. Then, inclining backwards, it escapes from under cover of the tendon, and descends obliquely across the medial surface of the carpus. At that point, it pierces the deep fascia and it soon divides into two *dorsal digital nerves* which supply the skin of the medial third of the back of the hand and the skin of the back of the little finger and medial half of the ring finger as far as the end of the second phalanx. The nerve can often be felt through the skin as it crosses the medial surface of the carpus.

The **terminal part of the radial nerve** (c. 6, 7) pierces the deep fascia at the lateral border of the front of the forearm about two inches above the styloid process of the radius. It descends towards the "anatomical snuff-box", crossing the tendons that overlie the lateral surface of the distal end of the radius, and divides into five *dorsal digital nerves*—two for the thumb and three for the fingers. They supply the skin of the lateral two-thirds of the back of the hand, and the skin of the back of the following digits as far as the end of the first phalanx—thumb, forefinger, middle finger, and lateral half of the ring finger. Sometimes the radial nerve sends a *palmar branch* to supply the skin over the part of the ball of the thumb that is nearest to the back of the first metacarpal. If the thumb is drawn, from behind forwards, across the distal end of the radius, the radial nerve can often be felt through the skin of the living hand ; and if the thumb of that hand is strongly extended to make the extensor tendons taut, the branches of the nerve can be felt as they cross the tendons.

The dorsal branch of the ulnar nerve often contains fibres of the seventh cervical nerve. When that is the case it gives off a branch that either replaces or assists the radial nerve in the supply of the contiguous halves of the ring and middle fingers.

The terminal parts of the backs of the digits are supplied

by twigs that curve backwards from the palmar digital nerves. But the extent to which the dorsal and the palmar digital nerves supply the backs of the digits is variable, and the dorsal nerves of the thumb and little finger may reach the root of the nail.

Palmar Digital Nerves.—There are seven palmar digital nerves. Two of them spring from the ulnar nerve and are distributed to the little finger and the medial half of the ring finger. The others arise from the median nerve and are distributed to the other three and a half digits. They are visible only on the digits at present. Their origin and course in the palm will be seen when the hand is dissected. They are accompanied by the palmar digital vessels, which are in front of them in the palm, and behind them on the sides of the digits. They supply the joints of the digits and the soft parts on the sides and the front of the digits and a variable extent of skin on the distal part of the back. Each terminates at the end of the digit by dividing into two branches, one of which ramifies in the pulp of the digit, and the other in the bed of the nail.

The **palmar digital branches of the ulnar nerve** (c. 8) arise from the superficial terminal branch of that nerve. They begin on the hypothenar eminence about an inch below the pisiform bone under cover of a small muscle called the palmaris brevis. The medial branch runs to the medial side of the little finger. The lateral branch pierces a fascial septum that extends backwards in the palm from the edge of the palmar aponeurosis, and descends towards the cleft between the little finger and the ring finger. Near the web, it divides into two branches which run along the contiguous sides of those fingers.

The **palmar digital branches of the median nerve** (c. 6, 7, 8) spring from the two terminal divisions of the median nerve in the upper part of the hollow of the palm. The medial two run towards the webs between the fore, middle, and ring fingers and divide to run along the contiguous sides of those fingers. The third runs to the radial side of the forefinger. The lateral two branches curve laterally round the lower margin of the thenar eminence, and run along the two sides of the thumb. The most medial of the digital branches of the median nerve sends a communicating twig to the adjoining branch of the ulnar nerve.

Lamellated Corpuscles (Pacinian bodies).—These are minute ovoid bodies that lie amidst the fat on the digits, and are attached to the ends of the fine terminal branches of digital nerves. They are *end-organs* associated with the sense of touch.

Dissection.—When the study of the cutaneous nerves of the hand is completed, the dissector will remove the remains of the superficial fascia from all parts of the limb, and will examine the deep fascia. Be very careful when removing the superficial fascia from the back of the hand, for the deep fascia is so thin there that it is liable to be removed with the superficial fascia

Deep Fascia

The deep fascia of the upper limb consists chiefly of transverse fibres, which are bound together by oblique and longitudinal fibres. The oblique and longitudinal fibres become specially developed in certain situations which will be noted later.

Turn first to the *scapular region*, and identify four muscles there—the deltoid, teres major and minor, and the infraspinatus. The first two have been examined already. The infraspinatus almost fills the infraspinous fossa. The teres minor is a narrow muscle that lies on the dorsum of the scapula along its lateral margin, so closely applied to the infraspinatus that it may appear to be part of it. The deep fascia on the anterior and lateral surfaces of the deltoid is fairly strong. On the posterior surface of the deltoid and on the other three muscles, it is very strong and dense, especially over the infraspinatus. From its deep surface, it sends in a strong septum between the infraspinatus and the teres minor to be attached to the dorsum of the scapula, and another between the two teres muscles to be attached to the lateral margin of the scapula. As it extends over the two teres muscles towards the deltoid, it splits into two layers which enclose the deltoid.

In the *upper arm*, the deep fascia consists largely of transverse fibres. It is strengthened by expansions from the tendons of the deltoid, the pectoralis major, and the latissimus dorsi. On the front, where it covers the biceps, it is thin, but it is much stronger at the back, over the triceps. From its deep surface, it sends in septa between muscles, including two strong sheets, called the **lateral** and **medial intermuscular** septa, which bind it to the lateral and medial supracondylar ridges of the humerus. Those septa will be examined when the upper arm is dissected.

At the *elbow*, it is thickened and strengthened by tendinous fibres which pass to it from the biceps and triceps muscles; and it is closely attached to the lateral and medial epicondyles of the humerus and to the olecranon. A special thickening, called the **bicipital aponeurosis** (lacertus fibrosus), is found at the front of the elbow (Fig. 28). It springs from the medial border of the upper part of the biceps tendon and the adjacent part of the muscle, and blends with the deep fascia on the medial side of the upper part of the forearm. It separates the median cubital vein, which lies superficial to it, from the brachial artery, which is deep to it. The anterior branch of the medial cutaneous nerve of the forearm usually passes between the aponeurosis and the median cubital vein.

In the *forearm*, the deep fascia is dense except in the lower part anteriorly. It is especially strong near the elbow, where it gives partial origin to the muscles which arise from the epicondyles. It sends in strong septa between the fleshy bellies of those muscles. The positions of the septa are indicated on the surface by white lines. At the back, it is firmly bound to the posterior border of the ulna, in its whole length, and thus separates the muscles on the medial surface of the ulna from those on the back.

At the *wrist* the transverse fibres of the deep fascia become very obvious. On the back, they form a well-marked band called the *extensor retinaculum*; on the front, they are incorporated in a shorter but much thicker band called the *flexor retinaculum* (Figs. 71 and 68).

Both the bands are attached to the adjacent bones; they act as straps which bind down tendons, and prevent them from springing away from the bones when the hand is bent forwards or backwards.

The **flexor retinaculum** (transverse carpal ligament) is a thick, strong band, about an inch square. It lies just distal to the best-marked crease at the lower end of the front of the forearm. It bridges across the carpal groove, converting it into a tunnel for the long flexor tendons to pass through. It is continuous above and below with the deep fascia of the forearm and palm. It is attached to the bones that form the sides of the carpal tunnel—the pisiform and the hook of os hamatum on the medial side, the tubercle of the scaphoid and the front of the trapezium on the lateral side. The dissector ascertained the position of those bones when he studied

the surface anatomy of the hand (p. 70). The retinaculum is hidden to a large extent at present by the structures that cross it and by the muscles of the thenar and hypothenar eminences that arise from it. Its connexions and relations will be examined fully when the hand is dissected. But it may be mentioned now that the attachment to the front of the trapezium is double: the retinaculum divides to be attached to both margins of the groove on the front of the trapezium, converting the groove into a narrow tunnel through which the tendon of the flexor carpi radialis descends to its insertion. And, further, a fascial slip, called the *superficial part* of the retinaculum, sometimes arises from its anterior surface and passes across the ulnar vessels and nerve to gain independent attachment to the front of the pisiform bone.

Turn now to the back of the limb and identify the **extensor retinaculum** (dorsal carpal ligament)—a thickened part of the deep fascia, nearly an inch wide, that lies obliquely across the back of the limb where the forearm joins the wrist. Its deep surface sends off septa that divide the space under its cover into six compartments. These compartments transmit the extensor tendons and are lined with their synovial sheaths. The compartments and the connexions of the retinaculum will be examined later; but note now that its medial end is attached to the medial surface of the carpus, and its lateral end is attached, on the front of the limb, to the sharp ridge on the distal end of the radius between its anterior and lateral surfaces; feel for this ridge in your own forearm.

Before you leave the *back of the limb*, note again how thin the deep fascia is on the back of the hand; as it passes on to the backs of the *digits*, it may become indistinguishable by adhering to the extensor tendons.

Turn again to the front, and examine the deep fascia of the *palm*. The portions that cover the thenar and hypothenar eminences are thin, and consist chiefly of transverse fibres. The intermediate portion is dense and strong, and is called the palmar aponeurosis.

The **palmar aponeurosis** consists of strong longitudinal fibres bound together by transverse fibres. It conceals and protects the main vessels and nerves and the tendons, as they pass towards the fingers. It is triangular in outline. Its apex blends with the distal border of the flexor retinaculum, and, more superficially, receives the tendon of the palmaris

longus. Its margins are continuous with the fascia on the thenar and hypothenar eminences; and they send septa into the depths of the palm, which will be dissected later. The distal margin or base lies at the level of the heads of the metacarpal bones, and it divides into processes—one for each finger and an occasional slender process for the thumb. Each process passes to the corresponding digit, where it blends with the *fibrous sheath* of the flexor tendons, and makes other connexions that will be examined when the hand is dissected.

The deep fascia on the palmar surfaces of the *digits* is thick and strong. It forms dense, curved plates or shields, called the **fibrous flexor sheaths.** These plates overlie the flexor tendons and are attached by their edges to the margins of the phalanges. In that way, they and the phalanges form tunnels in which the flexor tendons of the digits lie protected; and each tunnel is lined with the synovial sheath of the tendons.

SHOULDER (SCAPULAR REGION)

Muscles that connect the Trunk with the Shoulder Girdle. These muscles are the pectoralis minor, the inferior belly of the omo-hyoid, the levator scapulæ, the rhomboids, the serratus anterior, and the trapezius. They were examined when the pectoral region, the axilla, and the back were dissected; examine their attachments to the clavicle and scapula again.

Dissection.—Clean the ends of these muscles, if that has not been done already, and verify their attachments—pectoralis minor to the coracoid process; trapezius to the clavicle, acromion and spine of scapula; omo-hyoid from the upper border of the scapula; levator scapulæ and the rhomboids to the medial border; and serratus anterior to that border and the upper and lower angles on their costal aspect.

When you have reviewed these attachments, cut away the greater part of the muscles, leaving about one inch of each for future revision.

The *cutaneous nerves* of the shoulder and scapular region have been examined already. They are:—

1. Lateral supraclavicular nerves (pp. 24, 80).
2. Cutaneous branches from the circumflex nerve (axillary) (pp. 80, 81).
3. Cutaneous branches of the posterior primary rami of the upper thoracic nerves (p. 58).

The *deep fascia* also has been examined already (p. 86). The student should turn back to those pages and revise the nerves and the deep fascia before he goes on to the dissection of the deltoid muscle.

In the further dissection of the shoulder and scapular region the following parts must be studied :—

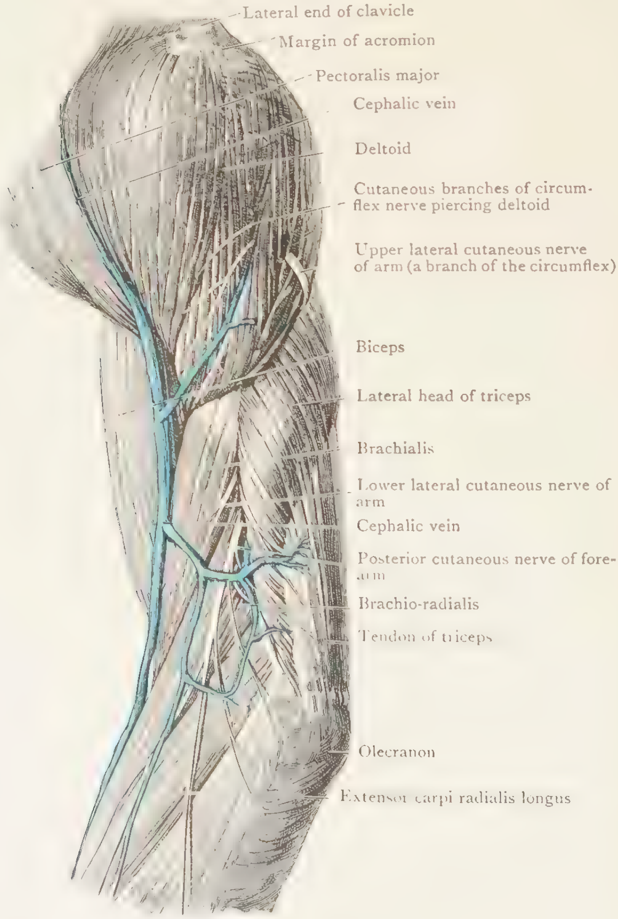


FIG. 32.—Deltoid Muscle and the lateral aspect of Upper Arm.

1. Deltoid muscle.
2. Sub-acromial bursa.
3. Anterior and posterior circumflex humeral vessels.
4. Circumflex nerve.
5. Circumflex scapular artery.
6. Subscapularis muscle.
7. Supraspinatus, infraspinatus, teres minor, and teres major muscles.
8. Bursæ in connexion with the shoulder joint.
9. Suprascapular nerve and artery.
10. Acromio-clavicular joint, and the coraco-acromial arch.

Dissection.—Place a small block in the axilla, fix the scapula to it with hooks, and bend the arm over the block to make the fibres of the deltoid tense. Detach the upper lateral cutaneous nerve of the arm from the deep fascia, and turn it backwards to the posterior border of the deltoid; then clean the deltoid. On the *left side*, commence at its posterior border; make an incision through the deep fascia along the whole length of that border and reflect the deep fascia forwards. On the *right side*, commence in front, where the fascia has already been partly reflected, and reflect the fascia backwards.

Deltoideus.—The deltoid muscle is composed of short, coarse fasciculi, separated by tendinous intersections; and, as its name implies, it is triangular in outline. It arises, by its upper end or base: (1) from the lateral third of the clavicle; (2) from the acromion; and (3) from the crest of the spine of the scapula. Its origin corresponds closely with the insertion of the trapezius. Its bundles or fasciculi converge rapidly as they pass to the pointed, tendinous insertion into the *deltoid tuberosity* of the humerus (Figs. 41, 43). The muscle is an abductor, and a medial and lateral rotator of the humerus; and it is supplied by the branches of the circumflex nerve which enter its deep surface.

Dissection.—Place the limb on its back. Release the axillary vessels and the nerves from the coracoid process, and clean the angle between the humerus and the scapula. Follow the *circumflex nerve* and the *posterior circumflex humeral artery* backwards to a cleft between the subscapularis and the teres major. Separate those muscles and a triangular interval will be displayed. A thick strap of muscle, called the *long head of the triceps*, crosses the triangular interval and divides it into a lateral part called the *quadrangular space* and a medial part called the *triangular space*. The circumflex nerve and the posterior humeral circumflex artery pass backwards through the quadrangular space. Now reverse the limb, push the posterior border of the deltoid forwards and find the circumflex nerve and the posterior humeral circumflex artery. They emerge from the quadrangular space and curve forwards round the surgical neck of the humerus.

At this stage, cut the deltoid from its origin, and turn it towards its insertion, taking care not to injure the circumflex arteries and nerve; and then clean the vessels and nerve.

Clean the circumflex nerve with caution. Secure a small *articular twig* that springs from it in the quadrangular space and passes up to the capsule of the shoulder joint. Note that the nerve splits into two branches after this twig is given off. Secure the *nerve to teres minor*, which springs from the posterior branch before it turns round the posterior border of the deltoid. Trace the branches of the anterior division into the deltoid.

Clean the teres major and minor muscles from end to end, preserving their nerves of supply. Clean also the long head of the triceps—upwards to its origin and downwards to its junction with the other heads of the triceps—and preserve its nerve supply.

Then, examine the *subacromial bursa*. It lies below the acromion, on the tendon of the *supraspinatus*. Thrust a blowpipe into it. If its wall is uninjured, it can be distended with air. Open it; gauge its extent with the finger, and note whether it is single or subdivided.

Turn the limb on to its back once more. Pull the *coraco-brachialis* and *short head of the biceps* medially, and expose the tendon of the *long head of the biceps* in the bicipital groove. Leave it lying there in the meantime, and pull the short head and the coraco-brachialis laterally to expose a thick tendon—the tendon of the *subscapularis*. Clean that tendon to its insertion. Clean also the *anterior humeral circumflex artery*.

Now, re-examine the structures that lie under cover of the deltoid, and note their relative positions.

Parts under cover of the Deltoid.—The deltoid covers the upper part of the humerus, and envelops the region of the shoulder joint behind, laterally, and in front; and its anterior border covers the coracoid process. It is separated from the shoulder joint by the muscles attached to the upper end of the humerus and by the subacromial bursa. The full, rounded appearance of the shoulder is due to the deltoid passing over the upper end of the humerus and those muscles. When the head of the humerus is dislocated, the muscle passes vertically from its origin to its insertion, and the dislocation is recognised by the squareness or flatness of the shoulder.

Under cover of the posterior part of the deltoid, there are portions of the muscles which spring from the posterior surface of the scapula, viz., the infraspinatus, teres major, and teres minor, and the upper part of the long head of the triceps, which arises from the upper part of the lateral border of the scapula. Under the middle part of the deltoid, there are the subacromial bursa, the tendon of the supraspinatus, and the upper part of the shaft of the humerus. The anterior part of the deltoid covers the long head of the biceps in the bicipital groove, the tendon of the subscapularis, and the coracoid process and the muscles and ligaments attached to it.

The muscle covers also the greater part of the circumflex nerve and vessels.

Subacromial Bursa.—This is a large bursal sac that separates the acromion and the upper part of the deltoid from

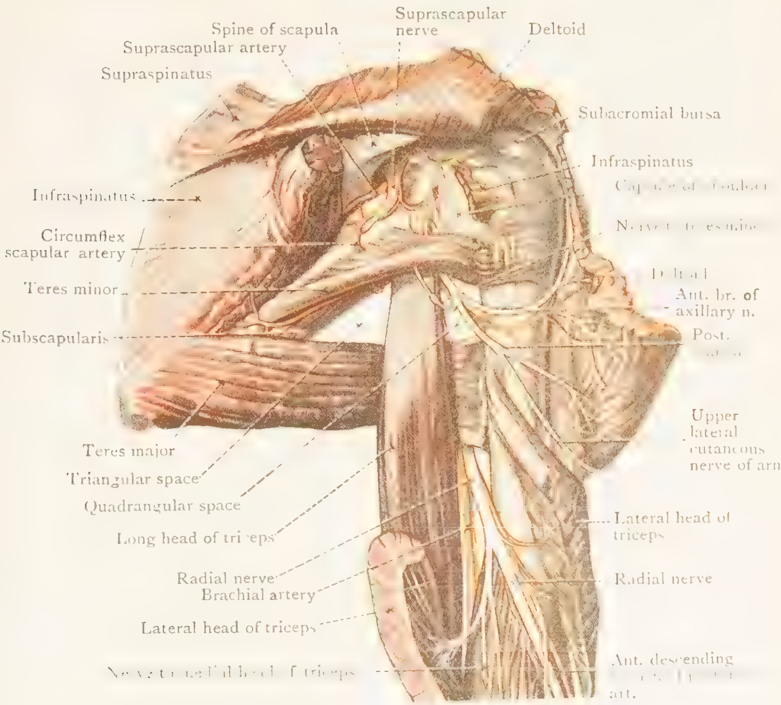


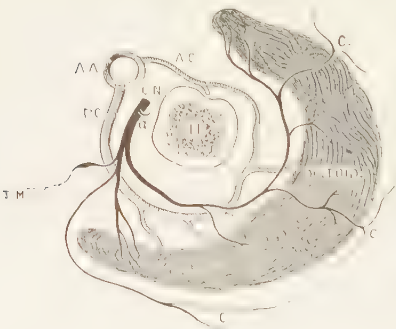
FIG. 33.—Dissection of the Scapular Region and back of the Upper Arm. The lateral head of the Triceps has been divided and turned aside to expose the groove on the Humerus for the radial nerve.

the muscles that lie on the upper surface of the capsule of the shoulder joint. It varies in size in different subjects, but may be as large as a hen's egg when distended; it may be a single sac, or subdivided by fibrous partitions. It facilitates the play of the upper end of the humerus and the attached muscles on the under aspect of the acromion and deltoid.

The Quadrangular and Triangular Spaces.—Neither of these so-called spaces has any real existence until the boundaries are artificially separated from one another. When viewed from the front the *triangular space* is bounded above by the subscapularis, below by the teres major, and laterally by the long head of the triceps; but at the back the teres minor replaces the subscapularis as the upper boundary. The circumflex scapular artery enters the space from the front, turns round the lateral border of the scapula, in front of the teres minor, and enters the infraspinous fossa.

The boundaries of the *quadrangular space*, as seen from the front, are the subscapularis above, the teres major below, the long head of the triceps medially, and the surgical neck of the humerus laterally. At the back the teres minor replaces the subscapularis as the upper boundary. Between the subscapularis and the teres minor the capsule of the shoulder joint forms the upper boundary of the space. The circumflex nerve and the posterior humeral circumflex vessels pass backwards through the space, directly below the capsule.

Circumflex Humeral Arteries. The *posterior circumflex humeral artery* was seen in the axilla (p. 43),



H. Transverse section of the humerus immediately below the tuberosities.
A.A. Axillary artery.
P.C. Posterior circumflex artery of the humerus.
A.C. Anterior circumflex artery of the humerus.
C.N. Circumflex nerve.
a. Articular branch.
T.M. Branch to teres minor.
C. Cutaneous branches.

FIG. 34.—Diagram of the Circumflex Arteries and Nerve.

springing from the axillary artery a short distance below the subscapular branch. It at once passes backwards, through the quadrangular space, and, winding round the surgical neck of the humerus, it is distributed in numerous branches to the deep surface of the deltoid muscle. Several twigs are given also to other muscles, to the shoulder joint, and to the skin.

It anastomoses with neighbouring arteries, the most important anastomosis being effected by a branch which it sends down to the profunda branch of the brachial artery.

The *anterior circumflex humeral artery* was described on p. 44. It is much smaller than the posterior circumflex artery. By the anastomosis of their branches, an arterial circle is formed round the surgical neck of the humerus.

Circumflex Nerve (Axillary nerve).—This nerve supplies: (1) an *articular twig* to the shoulder joint; (2) *muscular branches* to the deltoid and teres minor; and (3) *cutaneous branches* to the skin over the lower half of the deltoid.

It springs from the posterior cord of the brachial plexus, descends between the axillary artery and the subscapularis, turns round the lower border of the subscapularis, and passes backwards, with the posterior humeral circumflex artery, through the quadrangular space, to the back of the limb. There, it divides into an anterior and a posterior branch.

The *articular twig* takes origin from the trunk of the nerve in the quadrangular space, and enters the joint from below.

The *posterior branch* gives off the nerve to the teres minor, and, after furnishing a few twigs to the posterior part of the deltoid, curves round the posterior border of the deltoid, as the *upper lateral cutaneous nerve of the arm*, which runs forwards, branching to supply the skin over the lower half of the deltoid (Figs. 31, 32, 33). The nerve to the teres minor is distinguished by the presence of an oval, gangliform swelling upon it.

The *anterior branch* proceeds round the humerus with the posterior circumflex artery, and ends near the anterior border of the deltoid. It is distributed to the deltoid by numerous branches which enter the muscle through its deep surface, and send a few fine filaments through it to the skin.

> ***Dissection.***—Clean the coraco-acromial ligament, which extends from the coracoid process to the acromion. Before you begin to clean it, examine the pectoralis minor and see whether or not its tendon sends a slip through the ligament to the capsule of the shoulder joint.

Coraco-acromial Ligament and Arch.—The *coraco-acromial ligament* is a strong, flat band of a triangular shape. Its base is attached to the lateral border of the coracoid process; its apex is attached to the extremity of the

acromion (Figs. 46, 47, 49). Its upper surface is covered by the deltoid. Its lower surface is related to the subacromial bursa, which separates it from the supraspinatus muscle.

The *coraco-acromial arch* should be examined at the present stage, in order that its relationship to the subacromial bursa and the supraspinatus may be appreciated. It is the arch which overhangs and protects the shoulder joint It is formed by the coracoid process, the acromion, and the coraco-acromial ligament. It is separated from the shoulder joint by the subacromial bursa, the tendon of the supraspinatus, and the upper parts of the tendons of the infraspinatus and subscapularis.

The coraco acromial arch plays a very important part in the mechanism of the shoulder; it might almost be said to form a secondary socket for the humerus. The subacromial bursa, which intervenes between the arch and the muscles immediately covering the capsule of the shoulder joint, facilitates the movements of the upper end of the humerus on the lower surface of the arch.

Dissection.—Clear away the subacromial bursa and clean the supraspinatus, following it laterally to the humerus, and medially below the coraco-acromial arch and trapezius. Then, clean the fascia from the surface of the subscapularis. Now turn the limb and remove the fascia from the infraspinatus.

Scapular Muscles.—Under this head we include four muscles that arise from the dorsal surface of the scapula and one that springs from the costal surface.

The **supraspinatus** muscle arises from the medial two-thirds of the floor of the supraspinous fossa. From this origin the fibres converge, as they pass laterally, and, proceeding under the acromion, they end in a short, stout tendon, which is inserted into the top of the greater tuberosity of the humerus (Fig. 41, p. 112). The tendon is closely adherent to the capsule of the shoulder joint.

The supraspinatus is covered by the trapezius, the coraco-acromial arch, and the deltoid. It is supplied by the *suprascapular nerve*; and it is an abductor of the arm.

The **infraspinatus** muscle arises from the whole of the floor of the infraspinous fossa, with the exception of a small part of it near the neck of the scapula. Its tendon is closely adherent to the capsule of the shoulder joint, and is inserted

into the greater tuberosity behind the supraspinatus (Fig. 43, p. 117). Its lateral part is covered by the deltoid. Occasionally there is a small bursa between its tendon and the capsule of

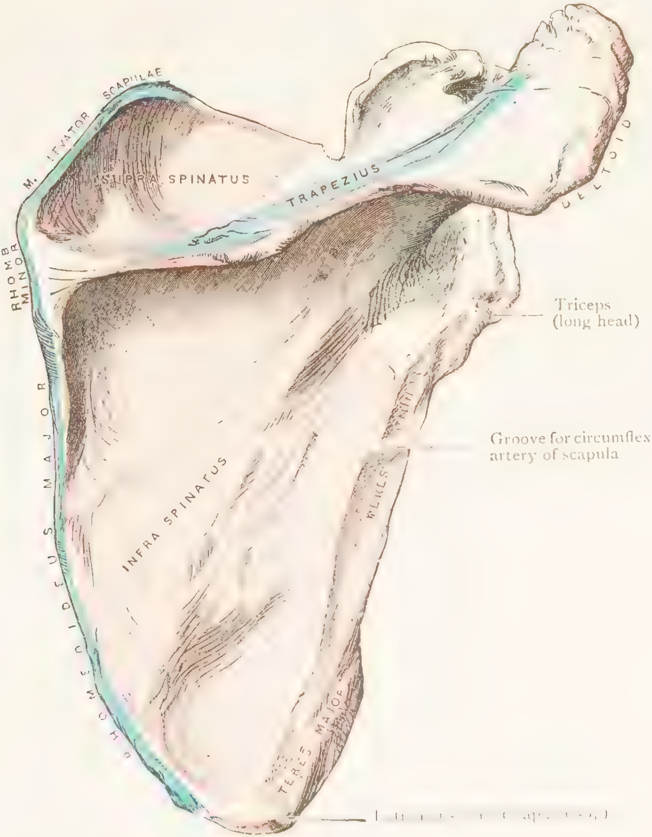


FIG. 35.—Dorsum of Scapula with the Attachments of Muscles mapped out.

the shoulder joint, and, if present, it may communicate with the shoulder joint. This muscle is supplied by the *suprascapular nerve*; and it is a lateral rotator of the arm.

The **teres minor** is the small muscle which lies along the lower border of the infraspinatus. It arises from an elongated, flat impression on the dorsum of the scapula along the lateral

border (Fig. 35). It is inserted by tendon into the back of the greater tuberosity of the humerus, and also, by fleshy fibres, into the shaft below the tuberosity for half an inch (Fig. 43, p. 117).

As it approaches its insertion it is separated from the teres major by the long head of the triceps brachii, and it is adherent to the capsule of the shoulder joint. The teres minor is supplied by a branch from the *circumflex nerve*. It is an adductor and lateral rotator of the arm.

The **teres major** is an elongated, rounded muscle that arises from the oval surface on the dorsum of the scapula close to the inferior angle (Fig. 35, p. 97). It is inserted into the medial lip of the bicipital groove (intertubercular sulcus) (Fig. 41, p. 112). It is supplied by the lower subscapular nerve, and it is an adductor, a medial rotator and an extensor of the arm. The triple relation of the latissimus dorsi to the teres major was explained on p. 63, and should be studied again.

The **subscapularis** is a thick, wide muscle that arises from the whole of the floor of the subscapular fossa, excepting a small portion near the neck of the scapula, but including the groove on the costal aspect of the lateral border (Fig. 21, p. 53). Its origin is strengthened by tendinous intersections, which are attached to the ridges on the costal surface of the scapula. The fleshy fibres converge upon a stout tendon which is adherent to the capsule of the shoulder joint, and is inserted into the lesser tuberosity of the humerus; a few of the lower fibres, however, gain independent insertion into the shaft below the tuberosity (Fig. 41).

As the muscle proceeds to its insertion, it passes under an arch formed by the coracoid process and the conjoined origin of the short head of the biceps brachii and the coracobrachialis. The subscapularis is supplied by the *upper* and *lower subscapular nerves*. It is an adductor and medial rotator of the arm.

Dissection. Pull the long head of the biceps out of the bicipital groove. Separate the tendon of the latissimus dorsi from the anterior surface of the teres major, noting the small fibrous slip which passes from it to the long head of the triceps (Fig. 12); then follow the tendon of the latissimus to its insertion. As you separate the tendons of the teres major and latissimus, see whether or not there is a small bursa between them near the humerus.

Insertions of Pectoralis Major, Latissimus Dorsi, and Teres Major.—These insertions are described on pp. 30, 63. The student should revise them now that the tendons are fully exposed. Note that the tendon of the teres major reaches a lower level than that of the latissimus near their insertion, and that, therefore, the last tendon on which the axillary artery rests is the teres major. The fibrous slip that connects the lower margin of the latissimus to the fascia on the long head of the triceps is of interest as it represents a muscle, called the *dorso-epitrochlearis*, which is present in certain animals.

Dissection.—Depress the upper border of the subscapularis as it passes below the coracoid process, and expose the *subscapular bursa*. Inflate the bursa with a blowpipe, and notice that, as air is blown in, the capsule of the shoulder joint is distended. Open the bursa and examine the interior.

Subscapular Bursa.—This is a prolongation of the synovial membrane of the shoulder joint through a large aperture in the upper and anterior part of the capsular ligament (Figs. 46, 47). It extends laterally between the subscapularis and the medial part of the capsule, and medially between the subscapularis and the front of the neck of the scapula and the root of the coracoid process. It facilitates the movement of the subscapularis on the front of the head and neck of the scapula.

Dissection.—Cut through the subscapularis vertically below the coracoid process, and detach the bursa from its deep surface. Turn the medial part of the muscle towards the medial border of the scapula, and note the anastomosis between the arteries on its deep surface. Turn the lateral portion towards the humerus, detaching it carefully from the capsule of the shoulder, and examine its insertion.

Divide the supraspinatus medial to the coracoid process. Turn the medial part towards the medial border of the scapula, and dissect its nerve of supply. Turn the lateral part towards the humerus, forcing it beneath the coraco-acromial arch, but avoiding injury to the supra-scapular nerve and vessels, which lie beneath it. As its tendon crosses the top of the shoulder joint, it must be carefully detached from the capsule.

Divide the infraspinatus medial to the lateral border of the spine of the scapula. Turn the medial part medially and dissect out the vessels and nerves from its deep surface. Follow the lateral part to its insertion, and, as it is displaced, take care not to injure the suprascapular nerve and vessels and the circumflex scapular vessels, which lie between it and the bone. As you separate it from the capsule of the shoulder joint, avoid injury to

the capsule. If there is a bursa under the tendon, see whether it communicates with the joint or not.

Divide the teres minor where the circumflex scapular artery passes between it and the bone ; turn its lateral part towards the insertion, avoiding injury to the capsule as you divide the adhesion between them.

Now, look for the *spino-glenoid ligament*—a weak band that bridges the spino-glenoid notch. Next, look for the *suprascapular ligament*, which bridges across the notch on the upper border of the scapula. Find there the suprascapular nerve and vessels. Clean them, following them down into the infraspinous fossa ; but be careful not to injure the branches of the nerve.

Spino-glenoid and Suprascapular Ligaments.—The *spino-glenoid ligament* is a loose fascial band that stretches across the spino-glenoid (great scapular) notch, from the scapular spine to the rim of the glenoid cavity ; it protects the suprascapular vessels and nerve as they descend into the infraspinous fossa.

The *suprascapular ligament* is a firm, fibrous band that passes from the upper border of the scapula to the root of the coracoid process. It bridges across the suprascapular notch, converting it into a foramen ; sometimes it is ossified. The suprascapular nerve passes backwards through the foramen below it, the suprascapular vessels above it ; and the inferior belly of the omo-hyoid muscle obtains partial origin from it.

Dissection. Revise the arteries which lie in relation with the borders and surfaces of the scapula, and dissect out the anastomoses between their branches.

The Anastomosis around the Scapula. An important and free anastomosis takes place between the branches of three arteries which lie in close relation with the scapula, viz. : (1) the deep branch of the transverse cervical artery ; (2) the suprascapular artery ; (3) the subscapular artery and its circumflex scapular branch.

The **deep branch of the transverse cervical artery** was seen when the levator scapulæ and the rhomboids were reflected during the dissection of the back. It runs downwards along the medial border of the scapula in front of, *i.e.* under cover of, the levator scapulæ and the rhomboids, between them and the insertion of the serratus anterior. It sends branches on to both surfaces of the scapula to supply the muscles and anastomose with the other arteries.

The **suprascapular artery** (transverse scapular) arises in the root of the neck, runs laterally behind the clavicle, slips

under cover of the trapezius, and descends to the upper border of the scapula. As it approaches the scapula, it sends a branch into the subscapular fossa. It then passes backwards over the suprascapular ligament, gives branches to the supraspinatus muscle, and descends through the spino-glenoid notch to end by ramifying in the infraspinatus.

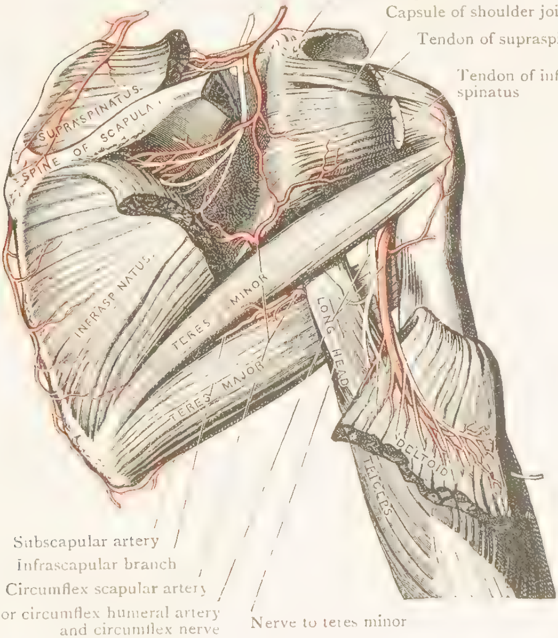


FIG. 36.—Anastomosing Arteries around the Scapula.

The **subscapular artery** is the largest branch of the axillary artery and has been examined already (p. 43). It runs downwards and backwards along the lower border of the subscapularis muscle, giving off branches that run on to both surfaces of the scapula; and it ends at the lower angle of the scapula in the latissimus dorsi muscle. Its largest branch is the *circumflex scapular* artery, which passes into the triangular space, sends branches into the subscapular fossa, and then

runs under cover of the teres minor into the infraspinous fossa to ramify and anastomose there.

When the dissector has followed the branches of the arteries just considered, he will realise that the arterial anastomosis around the scapula is very complete. The importance of these free communications is manifest when it is realised that two of the main arteries, viz., the suprascapular artery and the transverse cervical artery, spring indirectly from the first part of the subclavian artery ; whilst the third, viz., the subscapular, arises from the third part of the axillary. When, therefore, a ligature is applied to any part of the great arterial trunk of the upper limb, between the first stage of the subclavian and the third part of the axillary, the anastomosis around the scapula affords ample means of re-establishing the circulation.

Suprascapular Nerve.—This nerve arises from the fifth and sixth cervical nerves where they unite to form the upper trunk of the brachial plexus. It runs downwards and backwards in the neck, above the brachial plexus, passes under cover of the trapezius a little above the clavicle, and descends, in company with the suprascapular vessels, to the upper border of the scapula. It then passes downwards and backwards through the suprascapular notch, below the suprascapular ligament, which, at that point, separates it from the suprascapular artery and usually from the vein too, but the vein sometimes accompanies the nerve through the notch.

Having entered the supraspinous fossa, it gives one or two branches to the supraspinatus and filaments to the capsules of the acromio-clavicular and shoulder joints ; it then descends through the spino-glenoid notch under cover of the spino-glenoid ligament to end in the infraspinatus, having given additional twigs to the shoulder joint.

Ligaments that connect Clavicle with Scapula.—These ligaments are the coraco-clavicular ligament and the capsular ligament of the acromio-clavicular joint.

Dissection. Lift up the medial end of the clavicle to put tension on the *coraco-clavicular ligament*. Remove any parts of the deltoid and trapezius that conceal the ligament. Clean its surfaces and borders. Note that it is divisible into two parts. Look for a bursa between the two parts.

Next, remove the remains of the deltoid and trapezius muscles from the capsule of the *acromio-clavicular joint*, and clean the external surface of the capsule. Open the joint, and see if there is an *articular disc* inside the joint.

The **coraco-clavicular ligament** is a powerful ligament which binds the lateral part of the clavicle to the coracoid process. It consists of conoid and trapezoid parts that meet at an angle which is open anteriorly, and often contains a small bursa that diminishes the friction between them when the ligament is twisted during movements of the shoulder girdle.

The *conoid part* lies behind and medial to the trapezoid part. Its thick end is attached to the conoid tubercle of the clavicle (Fig. 9). The pointed end is attached to the upper surface of the coracoid process where the process bends forwards from its root. The *trapezoid part* is flat, thick and obliquely placed. It is attached to the trapezoid ridge of the clavicle and to the upper surface of the coracoid process.

The coraco-clavicular ligament helps to prevent dislocation of the acromial end of the clavicle, and, to a certain extent, it limits the movements of the acromio-clavicular joint. It is therefore an accessory ligament of that joint. It is also the main medium by which the scapula, and, indirectly, the other parts of the upper limb, are suspended from the clavicle. If the clavicle is broken medial to the attachment of the ligament, the upper limb, as a whole, at once falls—a characteristic sign of this common variety of fracture.

The **acromio-clavicular joint** is a synovial joint. The *capsular ligament* is attached to the margins of the articular surfaces; and its upper part is thickened to form the *acromio-clavicular ligament*. The cavity is usually partially subdivided by a wedge-shaped *articular disc* whose base is attached to the upper part of the capsular ligament.

The two surfaces of the joint are flat, and are ovoid in outline; and each slopes obliquely downwards and medially. The clavicle tends therefore to glide, upwards and laterally, on to the upper surface of the acromion. The tendency is counteracted by the strength of the acromio-clavicular ligament and by the coraco-clavicular ligament.

The joint capsule is supplied by filaments from the circumflex, suprascapular and pectoral nerves.

The only **movements** at this joint are slight gliding and rotatory movements. They occur in association with pivotal movements of the shoulder girdle as a whole at the sterno-clavicular joint, and allow the scapula to remain in apposition with the chest wall in different positions of the girdle. (*See also* Movements of Shoulder Joint, p. 129.)

FRONT OF UPPER ARM

In this region the following structures have to be studied :—

Cutaneous veins.
Cutaneous nerves of the upper arm.
Parts of the cutaneous nerves of the forearm.
The deep fascia.
The brachial artery and its branches.
The median, ulnar, radial, and musculo-cutaneous nerves.
The biceps, coraco-brachialis and brachialis muscles.

It is convenient to study at the same time the cubital fossa in front of the elbow.

The skin has been removed, the cutaneous veins and nerves have been dissected, and the deep fascia is now exposed and has been partly examined. Before you proceed farther, turn back and read again :—

1. The surface anatomy of the upper arm and the elbow (p. 67).
2. The cutaneous veins (p. 72).
3. The cutaneous nerves (p. 79).
4. The deep fascia of the upper arm and the elbow (p. 86).

When you have re-read those pages, proceed to investigate the deeper connexions of the deep fascia.

Dissection.—(1) Cut through the deep fascia along the upper and lower borders of the bicipital aponeurosis, from the medial margin of the biceps to the medial margin of the forearm, and leave the aponeurosis in position when the remainder of the deep fascia is reflected. (2) Make a longitudinal incision through the deep fascia along the middle line of the biceps. (3) At the level of the epicondyles, make a transverse incision through each of the flaps marked out by the longitudinal incision, and (4) reflect each of the two flaps to its own side. As the reflexion proceeds it will become evident that four septa pass from the deep surface of the deep fascia between the various muscles.

Septa of Deep Fascia.—A septum passes transversely from side to side between the biceps and the muscle that lies behind it—the brachialis (Figs. 38, 39); the musculo-cutaneous nerve is embedded in it. Another septum dips backwards to separate the brachialis from the muscles that spring from the lateral epicondylar ridge; embedded in it there are the radial nerve and the anterior descending branch of the profunda artery. But the strongest and most important septa are the *lateral* and *medial intermuscular septa*, which connect the investing layer of the deep fascia with the margins of the humerus, and, together with the humerus, divide the upper arm into two osteo-fascial *compartments*—an *anterior*

and a *posterior*; these two septa will be examined more fully after the back of the upper arm has been dissected.

The structures in the *posterior compartment* will be dissected later; they include all the structures in the back of the upper arm, except those that are subcutaneous.

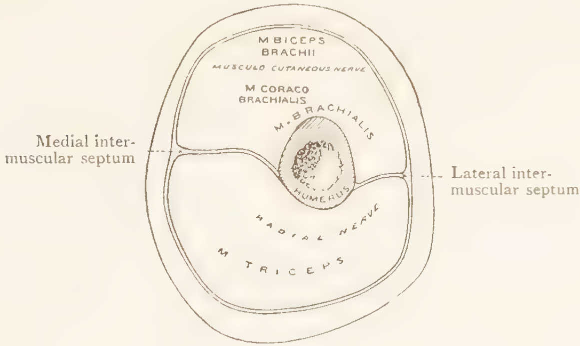


FIG. 37.—Diagram (after Turner) to show how the Upper Arm is divided by the intermuscular septa and the bone into an anterior and a posterior osteo-fascial compartment.

Anterior Compartment of Upper Arm.—This compartment has been opened by the reflexion of the deep fascia; the relative positions of its contents must be examined now.

The contents are :—

1. Three muscles that belong mainly to the upper arm—biceps brachialis and coraco-brachialis.
2. Parts of two muscles that belong mainly to the forearm—brachio-radialis and extensor carpi radialis longus.
3. Parts of all the terminal branches of the brachial plexus except the circumflex nerve.
4. Brachial artery, its venæ comitantes and the basilic vein.
5. Lymph vessels and a few lymph glands.

The *biceps brachii* is the most anterior muscle; the *brachialis* is under cover of its distal half and is closely applied to the front of the humerus, whilst the *coraco-brachialis* lies along the medial side of the proximal half of the biceps. The *brachio-radialis* and the *extensor carpi radialis longus* lie in the distal part of the compartment along the lateral side of the brachialis, to which they are closely applied; the brachio-radialis is the upper and the anterior of the two. The *brachial vessels* traverse the whole length of the compartment, in

relation with the medial border of the biceps. The *median nerve* also runs through the whole length of the compartment, lying lateral to the brachial artery in the proximal half, and medial to it in the distal half. The *basilic vein* enters the compartment at the middle of the upper arm, where it pierces the deep fascia; it then ascends along the medial side of the brachial artery. The *lymph vessels* accompany the veins; and the *lymph glands* lie alongside the artery.

Dissection.—Re-tie the piece of wood to which the axillary artery and the nerves were fixed to the coracoid process, and proceed to clean the brachial artery and its branches, its venæ comitantes, the proximal part of the basilic vein, and the accompanying nerves.

It is important that the artery should be disturbed as little as possible before its relations are studied. Therefore commence the dissection by cleaning the nerves and the veins, and take care not to injure the branches of the artery.

Begin with the *medial cutaneous nerve of the arm*; trace it to the point where it pierces the deep fascia, below which it has been dissected already. Next, follow the *medial cutaneous nerve of the forearm* to the point where it pierces the deep fascia, and note the branches which it gives off before it pierces the fascia.

Clean the *basilic vein* and push it forwards. Pick up the *ulnar nerve*, and follow it downwards till it pierces the medial intermuscular septum. Next, follow the *median nerve* to the front of the elbow; and then clean the *venæ comitantes* of the brachial artery, following them up to the axillary vein. At the same time, clean the *brachial artery*, dividing the cross channels that connect its venæ comitantes.

Push the upper part of the brachial artery forwards, to get at the *radial nerve*. Follow the nerve to the upper end of the spiral groove, and follow the branches which it gives off before it disappears.

Now, turn to the branches of the brachial artery. Pick up each of them in turn, and clean it. The named branches spring from its medial side or from the back of it (see p. 109).

Median Nerve.—The median nerve arises in the axilla by two roots—one from the medial cord of the brachial plexus and one from the lateral cord. The medial root crosses the front of the third part of the axillary artery to unite with the lateral root. The nerve thus formed descends, along the lateral side of the distal part of the axillary artery and the proximal half of the brachial artery, to the level of the insertion of the coraco-brachialis; there it crosses in front of the brachial artery (sometimes behind) and descends along its medial side to the bend of the elbow, where it enters the forearm. It gives off no branches either in the axilla or in the upper arm.

Ulnar Nerve.—The ulnar nerve arises from the medial cord of the brachial plexus, and is its largest branch; occasionally the lateral cord contributes a slender root which brings fibres of the seventh cervical nerve to the ulnar nerve. Like the other large nerves that spring from the plexus, it arises opposite the infero-lateral border of the pectoralis minor, near the coracoid process, at the junction of the second and third parts of the axillary artery. It descends, along the medial side of the third part of the axillary artery and of the proximal half of the brachial artery, to the insertion of the coraco-brachialis; it then leaves the brachial artery and, accompanied by the ulnar collateral artery, passes downwards and backwards through the medial intermuscular septum, into the posterior compartment. In the posterior compartment it descends, along the medial head of the triceps, to the back of the medial epicondyle. Do not follow it into the posterior compartment at present; it will be dissected there at a later period. Like the median nerve, it gives off no branches whilst it is in the axilla and the upper arm. The branch of the radial nerve to the lower part of the medial head of the triceps sometimes accompanies the ulnar nerve as far as the lower third of the upper arm.

Brachial Artery.—The brachial artery is the direct continuation of the axillary artery, and begins, therefore, at the lower border of the teres major; it passes, downwards and slightly laterally, to the cubital fossa, where, at the level of the neck of the radius, it divides into its two terminal branches —the radial and the ulnar arteries. In the proximal part of the upper arm, it lies to the medial side of the humerus, but as it approaches the elbow it passes to the front of the humerus.

This change of position must be borne in mind when pressure is applied to the vessel with the view of controlling the flow of blood through it. In the proximal part the pressure must be directed laterally and backwards, and in the distal part directly backwards.

Relations.—The brachial artery is superficial in the whole of its length. To expose it, you require to reflect only the skin and the fascia; but it is overlapped, from the lateral side, by the medial margins of the coraco-brachialis and biceps brachii (see Figs. 15, 38). At the bend of the elbow it is crossed superficially by the bicipital aponeurosis, which intervenes between it and the median cubital vein.

The basilic vein lies to the medial side of the artery, on a slightly more posterior plane. In the distal part of the arm, the vein is separated from the artery by the deep fascia; but in the proximal part, after the vein has pierced the fascia, it comes into closer relationship with the artery. The two venæ comitantes are closely applied to the sides of the artery, and the numerous connecting branches which pass between them, both in front of and behind the artery, make the relationship still more intimate.

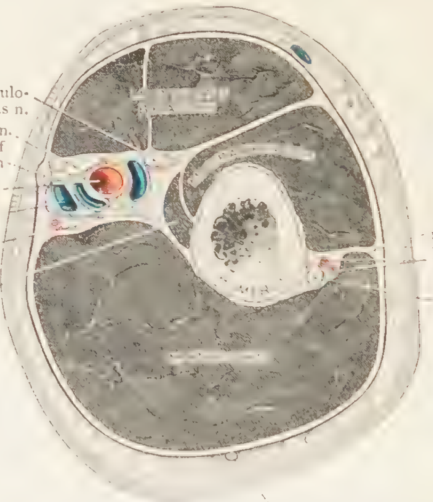


FIG. 38.—Section through the Middle of the Right Upper Arm.

The muscles behind the brachial artery are, from above downwards, the long and medial heads of the triceps, the coraco-brachialis (at its insertion), and the brachialis. The long head of the triceps is separated from the artery by the radial nerve and the profunda vessels; the other muscles are in close relation.

The nerves related to the brachial artery are the median, the ulnar, the radial and the medial cutaneous nerve of the forearm. The median nerve lies on the lateral side in the proximal half of the upper arm; it crosses in front of the artery at the insertion of the coraco-brachialis, and, in the

distal half and in the cubital fossa, it lies along the medial side of the artery. The ulnar nerve and the medial cutaneous nerve of the forearm lie close to the medial side of the artery as far as the insertion of the coraco-brachialis. They then leave it; the ulnar nerve inclines backwards to pierce the medial intermuscular septum; the medial cutaneous nerve of the forearm inclines forwards and medially to pierce the

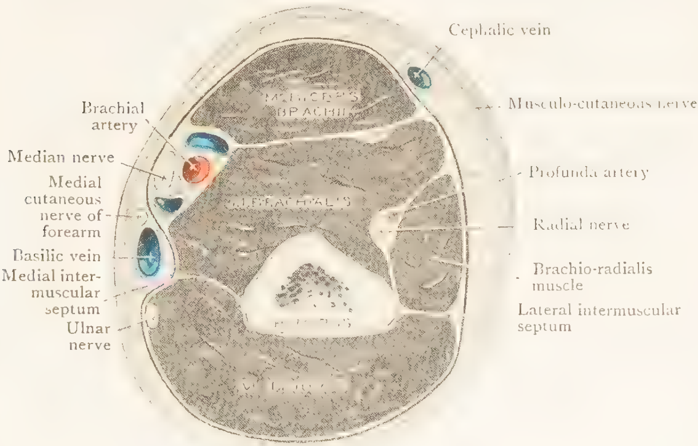


FIG. 39.—Section through the Distal Third of the Right Upper Arm.

deep fascia. The radial nerve is behind the uppermost inch of the artery, but it soon leaves it by passing downwards and laterally into the spiral groove, between the medial and the lateral heads of the triceps.

Branches of the Brachial Artery.—Several branches arise from the brachial artery. Those which arise from its lateral side are irregular in number, origin and size, and are distributed to the muscles and skin on the front of the arm. The branches which proceed from the medial side and the back of the parent trunk are named, from above downwards:—

1. Profunda brachii.	3. Nutrient, to humerus.
2. Ulnar collateral.	4. Supratrochlear.

The *profunda brachii artery* is the largest branch. It takes origin about an inch or less below the lower margin of

the teres major, and accompanies the radial nerve to the back of the arm. Consequently, only a short part of the vessel is seen in the present dissection.

The *ulnar collateral artery* is a long, slender artery which

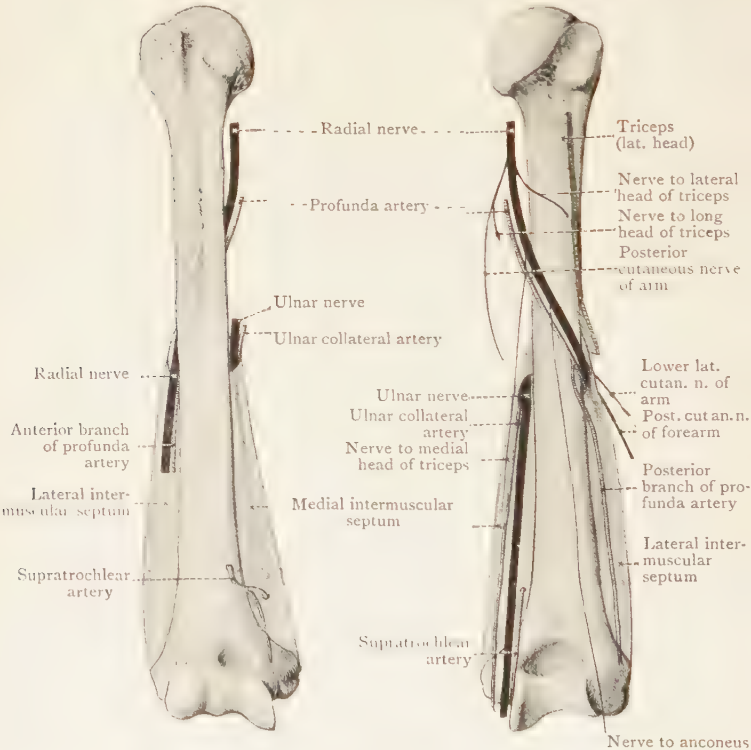


FIG. 40.—Diagram to show relation of Radial Nerve to the Humerus, and of Vessels and Nerves to the Intermuscular Septa.

can be recognised from the fact that it accompanies the ulnar nerve. Its origin is variable. It usually takes origin opposite the insertion of the coraco-brachialis, but very frequently it arises in common with the profunda artery. It pierces the medial intermuscular septum with the ulnar nerve, and descends behind that septum to the interval between the olecranon and the medial epicondyle.

The *nutrient artery* may arise from the brachial trunk or from the ulnar collateral artery. Look for it at the distal border of the insertion of the coraco-brachialis; and do not be confident that you have found it till you have traced it into the nutrient foramen of the humerus. When the nutrient artery is not seen in its usual position, it probably arises from the profunda artery, and will be found in the dissection of the back of the arm.

The *supratrochlear artery* (inferior ulnar collateral) arises about two inches above the bend of the elbow, and runs medially on the brachialis. It soon divides into an anterior branch and a larger posterior branch. The *anterior branch* is carried downwards in front of the medial epicondyle, in the interval between the brachialis and a muscle of the forearm called the pronator teres. The *posterior branch* pierces the medial intermuscular septum, and will be seen, at a later stage, in the posterior compartment of the arm.

Dissection.—Clean the biceps brachii, but do not injure the bicipital aponeurosis. Clean the coraco-brachialis; separate it carefully from the short head of the biceps, and find the musculo-cutaneous nerve as it leaves the lateral surface of the coraco-brachialis. Follow the musculo-cutaneous nerve to the point where it emerges at the lateral border of the tendon of the biceps. Clean the brachialis as far as the bend of the elbow.

Musculo-cutaneous Nerve.—This nerve arises from the lateral cord of the brachial plexus, opposite the infero-lateral border of the pectoralis minor. Inclining laterally, it enters the deep surface of the coraco-brachialis, a little below the pectoralis minor, and, having perforated the coraco-brachialis, it passes between the biceps brachii and the brachialis. It proceeds obliquely downwards, between those muscles, until it approaches the bend of the elbow, where it pierces the deep fascia at the lateral border of the tendon of the biceps. From that point it has already been traced as the *lateral cutaneous nerve of the forearm* (p. 82).

The musculo-cutaneous nerve supplies branches to the coraco-brachialis, the biceps and the brachialis. The branch to the coraco-brachialis is given off before the parent trunk enters the muscle; the branches to the biceps brachii and brachialis issue from it as it lies between them.

Coraco-brachialis.—This fairly slender, rounded muscle takes origin from the tip of the coracoid process, in conjunc-

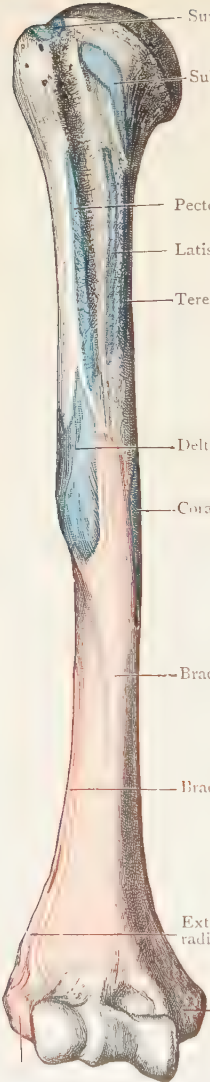


FIG. 41.—Front of Humerus with Muscular Attachments mapped out.

tion with the short head of the biceps brachii. It descends along the medial margin of the biceps, and is inserted into the medial margin of the humerus, about its middle. It is a flexor and adductor of the upper arm.

Biceps Brachii.—The biceps muscle arises from the scapula by two heads. The *short* or *medial head* springs from the tip of the coracoid process in conjunction with the coraco-brachialis (Fig. 21, p. 53). The *long* or *lateral head* is a rounded tendon which occupies the bicipital groove (intertubercular sulcus) of the humerus. Its origin from the supraglenoid tubercle of the scapula cannot be studied at this stage, because it is within the shoulder joint. Both heads swell out into elongated fleshy bellies, which are united in the distal third of the upper arm. Towards the bend of the elbow the fleshy fibres converge upon a stout, short tendon, which is inserted into the posterior part of the tuberosity of the radius. The insertion will be more fully examined at a later period; but it may be noticed, in the meantime, that a synovial bursa is interposed between

the tendon and the smooth, anterior part of the radial tuberosity.

The dissector has already taken notice of the *bicipital aponeurosis* (lacertus fibrosus), and has separated it, artificially, from the deep fascia. Observe now that it springs from the tendon of the biceps brachii, and also from the lower end of the short head of the muscle.

The biceps brachii is supplied by the musculo-cutaneous nerve. It is a supinator and flexor of the forearm.

Brachialis.—The brachialis is a strong muscle that arises from the front of the distal half of the shaft of the humerus and from the intermuscular septa. The origin from the bone is prolonged upwards on each side of the insertion of the deltoid. The fibres converge to be inserted into the front of the coronoid process of the ulna by a short, thick tendon. The muscle lies partly under cover of the biceps brachii, but projects beyond it on each side. It is overlapped on its medial side by the pronator teres, and on the lateral side by the brachio-radialis and extensor carpi radialis longus. Its deep surface is closely connected to the anterior part of the capsule of the elbow joint.

Its chief nerve of supply, from the *musculo-cutaneous*, has already been secured, but it receives also one or two small twigs from the radial nerve which are given off under cover of the brachio-radialis. It is a flexor of the elbow joint.

> ***Dissection.***—Separate the brachio-radialis from the brachialis muscle, and dissect out the radial nerve, with the anterior descending branch of the profunda artery, which lie deeply in the interval between the muscles. Look also for the twigs which are given by the radial nerve to the brachialis, the brachio-radialis, and the extensor carpi radialis longus.

Cubital Fossa

The cubital fossa is the hollow in front of the elbow. It corresponds to the popliteal fossa at the back of the knee.

It is triangular in outline, possessing an apex or lower angle, a base, and lateral and medial boundaries. Its superficial and deep walls are called its roof and its floor.

The *roof* is formed by the deep fascia, which is strengthened by the bicipital aponeurosis (Figs. 28, 42). It is pierced by a communication between the deep veins and the median cubital

vein. It is covered by the skin and by superficial fascia containing a portion of the cephalic vein, a portion of the basilic vein, the median cubital vein, the anterior branch of the medial cutaneous nerve of the forearm, and the lateral cutaneous nerve of the forearm.

The *base* is an imaginary line drawn between the two

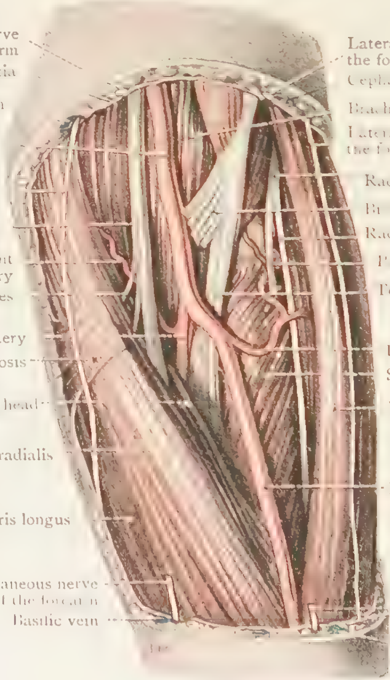


FIG. 42.—Dissection of the Left Cubital Fossa.

epicondyles. The *medial border* is the pronator teres muscle. The *lateral border* is the brachio-radialis. Those two muscles meet at the *apex*, where the brachio-radialis overlaps the pronator teres. The *floor* is formed by the distal part of the brachialis muscle and the anterior part of a muscle called the supinator, which is wrapped round the proximal third of the shaft of the radius.

The contents of the fossa are :—A quantity of fat ; the

termination of the brachial artery; the proximal parts of the radial and ulnar arteries; the tendon of the biceps brachii, on the lateral side of the brachial artery; and the median nerve, on the medial side of the artery.

The ulnar artery leaves the space by passing under cover of the pronator teres; the radial artery descends through the apex of the fossa, overlapped by the brachio-radialis. The median nerve, having given off branches from its medial side, disappears between the two heads of the pronator teres. The tendon of the biceps brachii inclines backwards, between the two bones of the forearm, to reach its insertion.

Other structures which are under cover of the boundaries but are not strictly within the fossa are: The radial nerve and its posterior interosseous branch; the anterior descending branch of the profunda artery; the radial recurrent artery; the ulnar recurrent arteries; and twigs of the ulnar collateral and supratrochlear arteries.

Dissection.—The fascial roof of the cubital fossa was partially destroyed when the deep fascia of the front of the arm was reflected, but the bicipital aponeurosis is still in position. Cut across the aponeurosis near the biceps (Fig. 42), reflect it towards the medial border of the forearm, and then proceed to clean the contents of the fossa.

Pull aside the boundaries with hooks, and commence with the *median nerve*. Follow it to the point where it disappears between the heads of the pronator teres, and secure its branches.

Clean the *brachial*, *radial* and *ulnar arteries*, from above downwards. If their venæ comitantes are in the way, remove them. Secure and clean the branches that arise from the radial and ulnar arteries in the fossa. A *radial recurrent artery* springs from the radial, and ascends to the front of the lateral epicondyle. *Anterior* and *posterior ulnar recurrent arteries* spring from the ulnar and run to the front and back of the medial epicondyle. Clean the *tendon of the biceps brachii* and follow it to its insertion. Look for its bursa and open it.

To facilitate the cleaning of the floor and to expose structures which are not strictly contents of the fossa, but lie under cover of its boundaries, bend the elbow slightly, and pull the boundaries of the fossa still wider apart. Find the *radial nerve*, and the anterior descending branch of the *profunda artery* at the level of the lateral epicondyle, between the brachio-radialis and the brachialis. Follow the nerve and its *posterior interosseous branch*. The posterior interosseous nerve disappears into the substance of the supinator. The radial nerve descends into the forearm between the brachio-radialis and the supinator.

After the contents of the cubital fossa have been cleaned and their relative positions noted, turn to the dissection of the back of the upper arm.

BACK OF UPPER ARM

In this region, in addition to the cutaneous nerves, the following are the structures which must be studied : —

1. The triceps muscle.
2. The profunda brachii artery, and the radial nerve.
3. The ulnar collateral artery, and the ulnar nerve.
4. The posterior branch of the supratrochlear artery.
5. The subanconeus muscle.

The skin and the superficial fascia have been removed, but the cutaneous nerves are still present ; the dissector should revise them before proceeding with the dissection.

On the medial side are branches of the intercosto-brachial nerve ; lateral to them lies the posterior cutaneous nerve of the arm—a branch of the radial nerve ; and, along the lateral margin, there is the posterior cutaneous nerve of the forearm —also a branch of the radial nerve (see p. 81).

Dissection.— Make a vertical incision through the deep fascia as far as the olecranon, and a transverse incision across the olecranon from one epicondyle to the other, taking care not to injure the posterior cutaneous nerve of the forearm. Reflect the flaps of deep fascia to the sides until their continuity with the medial and lateral intermuscular septa is demonstrated. As the medial flap is reflected, avoid injury to the ulnar nerve and the ulnar collateral artery, which accompanies it. Next, clean the triceps muscle and define its attachments carefully.

Triceps.—The triceps muscle occupies the entire posterior osteo fascial compartment of the arm. It arises by a *long head* from the scapula, and by two shorter heads—*lateral* and *medial*—from the humerus. The fleshy fibres of the three heads join a common tendon which is inserted into the upper surface of the olecranon.

The superficial part of the muscle is, for the most part, formed by the long and lateral heads. The medial head is deeply placed ; but a very small portion of it appears superficially, above the elbow, on each side of the common tendon of insertion.

The *long head* of the triceps arises, by a flattened tendon, from the infraglenoid tubercle of the scapula, in the interval between the teres minor and subscapularis muscles (Fig. 35).

The *two humeral heads* take origin from the back of the humerus ; and if it is borne in mind that no fibres arise from

the spiral groove that lodges the radial nerve and that the groove intervenes between the origins of the two heads, their relations will be easily understood. Take a humerus, identify the spiral groove, and map out the areas of attachment of the humeral heads of the triceps as they are exhibited in the dissected part.

The *lateral head* of the triceps arises from the lateral border of the humerus above the spiral groove—*i.e.* from a rough strip that descends from the back of the greater tuberosity to the groove—and also from the fascial sheet that bridges across the groove for the protection of the profunda brachii artery and the radial nerve.

The *medial head* of the triceps arises from the whole of the back of the humerus below the spiral groove, and from the intermuscular septa. Though it is on the back, and is below the spiral groove, yet its upper end, which is narrow and pointed, reaches the insertion of the teres major, and is seen better on the front of the limb than on the back. The origin gradually widens as the groove passes towards the lateral border of the humerus; and in its distal third it covers the whole width of the back

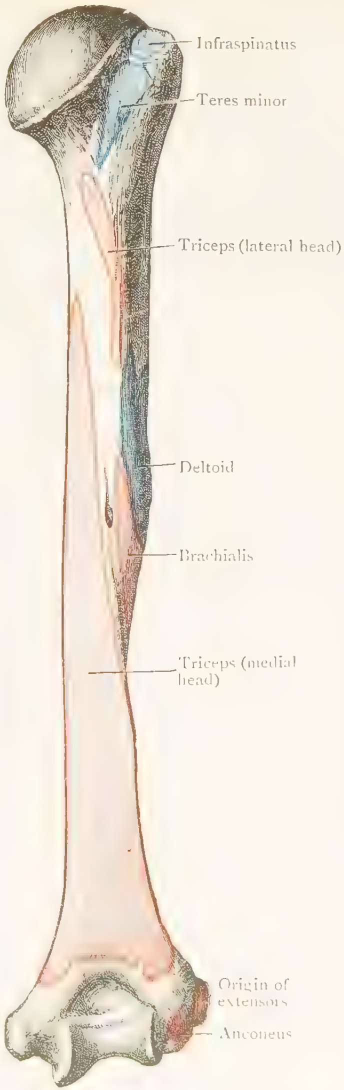


FIG. 43.—Back of Humerus with muscular attachments mapped out

of the humerus (Fig. 43). The medial head of the triceps, therefore, has very much the same origin from the back of the bone that the brachialis has from the front.

Study the *common tendon of insertion* of the triceps. The long and the lateral heads end in a broad, flat tendon which is inserted into the back part of the upper surface of the olecranon, and at the same time gives off, on the lateral side, a strong expansion to the fascia of the forearm where it covers a muscle, called the anconeus, which lies at the lateral side of the olecranon. The short, fleshy fibres of the medial head are, for the most part, inserted into the deep surface of the common tendon, but a considerable number find direct attachment to the olecranon, whilst a few of the lowest fibres are inserted into the posterior part of the capsule of the elbow joint. The latter fibres have been described as a separate muscle under the name of *subanconeus*. A small bursa, which lies on the top of the olecranon, separates the common tendon from the posterior ligament of the elbow joint.

The triceps is supplied by branches from the *radial nerve*. It is an extensor of the elbow joint and an adductor of the arm.

Dissection.—To expose the radial nerve and the profunda brachii artery fully, divide the lateral head of the triceps. Thrust the handle of a knife along the spiral groove, and deep to the muscle. The handle will then give the direction in which the lateral head of the triceps should be severed. Beyond cleaning the nerve and its branches and the profunda brachii artery, as they lie in the groove, no further dissection is necessary.

Radial Nerve. The radial nerve is a terminal branch of the posterior cord of the brachial plexus. It is the thickest branch of that plexus; and, like the ulnar and median nerves, it extends from the axilla to the hand. In the first instance, the radial nerve descends behind the third part of the axillary artery and the proximal part of the brachial artery. It soon leaves the front of the arm, however, and, inclining backwards, with the *profunda artery*, enters the interval between the long and the medial heads of the triceps, and reaches the spiral groove. In that groove, it passes round the back of the humerus, under cover of the lateral head of the triceps; and, on the lateral side of the limb, it pierces the lateral intermuscular septum and passes into the anterior compartment of the arm, where it has been dissected already. There, it lies deeply, in the interval that separates the brachialis from the brachio-radialis and extensor carpi radialis longus. At the

level of the lateral epicondyle of the humerus, it gives off the posterior interosseous nerve, and then descends, in front of the capsule of the elbow joint, into the forearm.

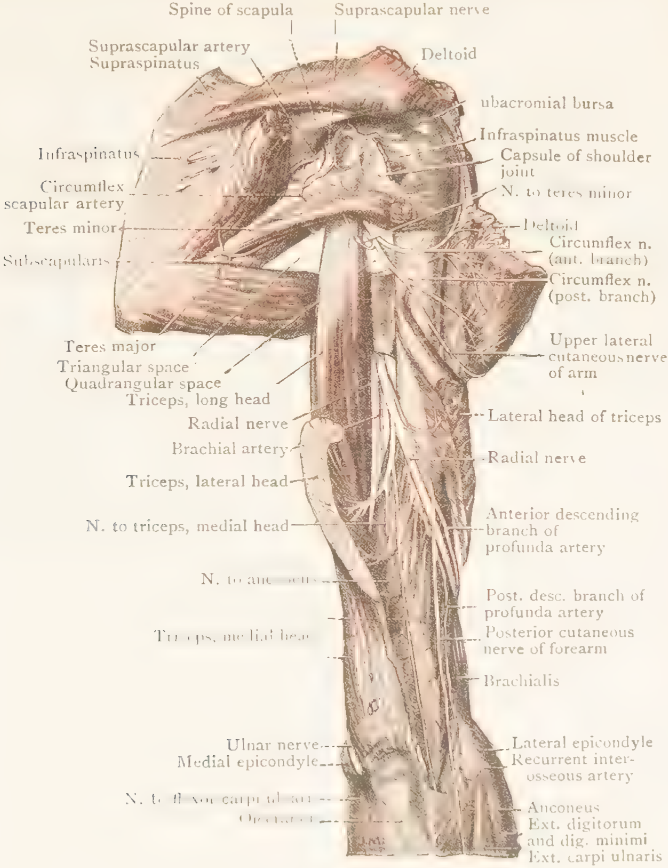


FIG. 44.—Dissection of the Back of Shoulder and Upper Arm. The lateral head of the Triceps has been divided and turned aside to expose the spiral groove on the Humerus for the radial nerve.

The radial nerve presents, therefore, very different relations as it is traced through the axilla and upper arm :—(1) in front of the subscapularis, latissimus dorsi, teres major, and long head of the triceps, and behind the axillary and brachial

arteries ; (2) between the long and the medial heads of the triceps ; (3) in the spiral groove, between the bone and the lateral head of the triceps : (4) in the interval between the brachialis on the medial side, and the brachio-radialis and extensor carpi radialis longus on the lateral side (Fig. 80).

The branches which proceed from the radial nerve are *muscular*, *cutaneous*, and *articular*.

The *cutaneous branches* are three in number, and have already been traced. They are—(1) the posterior cutaneous nerve of the arm, (2) lower lateral cutaneous nerve of the arm, and (3) the posterior cutaneous nerve of the forearm.

The part of the radial nerve which is continued into the forearm is cutaneous ; but it does not pierce the deep fascia till it approaches the wrist ; and its distribution is to the skin of the back of the hand and the digits (p. 84).

The *muscular branches* are distributed to the three heads of the triceps, to the anconeus, to the lateral fibres of the brachialis, to the brachio radialis, and to the extensor carpi radialis longus. The branches to the three last-named muscles spring from the trunk of the nerve after it has pierced the lateral intermuscular septum. One of the branches to the medial head of the triceps is a long, slender nerve that often accompanies the ulnar nerve in part of its course in the upper arm. The branch to the anconeus also is a long, slender twig ; it passes through the substance of the medial head of the triceps to reach the anconeus (Fig. 44).

The *articular branches* arise near the elbow, and supply the capsule of the elbow joint.

The *posterior interosseous nerve* has an extensive distribution to the muscles on the back of the forearm and to the radio carpal and carpal joints, and will be dissected later (p. 174).

Profunda Brachii Artery.—The profunda artery takes origin from the brachial trunk about one inch below the teres major muscle. It accompanies the radial nerve through the spiral groove. Before it reaches the lateral intermuscular septum, it divides into two *descending* terminal branches—an anterior and a posterior. The *anterior branch* accompanies the radial nerve through the septum, and follows it as far as the front of the elbow joint. The *posterior branch* is larger ; it descends over the back of the lateral intermuscular septum to the back of the lateral epicondyle.

The other branches are distributed chiefly to the triceps; but a *nutrient* artery often springs from the profunda and enters the humerus through the floor of the spiral groove; and an *ascending branch* runs upwards between the long and lateral heads of the triceps to anastomose with the *posterior circumflex artery of the humerus*, and thus form a link between the axillary and brachial systems of branches.

Dissection.—Trace the *ulnar nerve* and the *ulnar collateral artery*, as they run downwards, over the back of the medial intermuscular septum, to the epicondyle. Clean also the posterior branch of the *supratrochlear artery*. Divide the triceps a short distance above the olecranon, and look for a transverse artery that lies immediately above the elbow joint. At the same time, look for the *subanconeus* muscle. Lastly, raise the tendon of the triceps, and look for the bursa that lies under cover of it.

When the dissection is completed, revise the intermuscular septa, which are now fully exposed.

Medial and Lateral Intermuscular Septa. The **medial intermuscular septum** is the stronger. It connects the investing deep fascia with the medial border of the humerus, and separates the medial head of the triceps from the brachialis, giving attachment to both the muscles. It extends, as a strong membrane, from the medial epicondyle to the insertion of the coraco-brachialis. Then it becomes less distinct, but it can be traced upwards to the medial lip of the bicipital groove. At the level of the insertion of the coraco-brachialis, it is pierced by the *ulnar nerve* and the *ulnar collateral artery*, which, after piercing it, descend behind it to the medial epicondyle and are covered by a thin layer of fleshy fibres that belong to the medial head of the triceps. A short distance above the medial epicondyle, it is pierced by the *posterior branch of the supratrochlear artery*, which, in that position, is connected with the posterior branch of the profunda by a transverse artery that crosses the back of the humerus immediately above the capsule of the elbow joint.

The **lateral intermusclular septum** connects the deep fascia with the lateral border of the humerus. It extends from the lateral epicondyle to the insertion of the deltoid muscle, with which it blends. It separates the lateral part of the medial head of the triceps, which arises from its posterior surface, from three muscles that spring from its anterior surface—the upper lateral part of the brachialis, the brachio-radialis and the extensor carpi radialis longus. At the junction of the

middle and distal thirds of the upper arm, it is pierced by the *radial nerve* and the *anterior branch of the profunda artery*, which afterwards descend in front of it, in the interval that separates the brachialis from the brachio-radialis and the extensor carpi radialis longus.

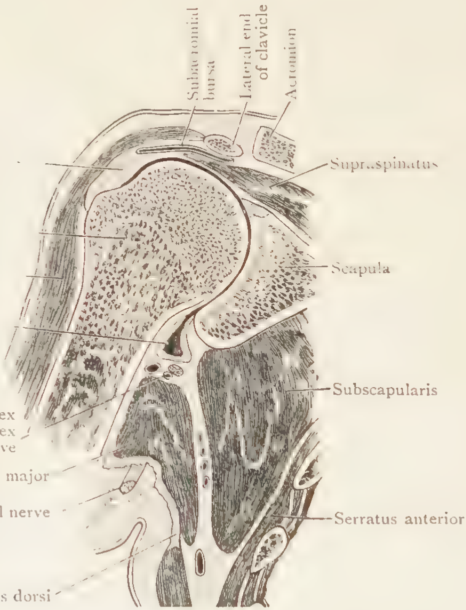


FIG. 45.—Coronal or vertical transverse section through the Left Shoulder joint. (Viewed from behind. Cf. Fig. 48.)

SHOULDER JOINT

After the structures in the upper arm have been studied the student will dissect the shoulder joint, in order that he may examine the ligaments before they have become too dry.

The shoulder joint belongs to the ball-and-socket group of synovial joints. The socket is the glenoid cavity of the scapula, and the ball is the head of the humerus.

In no joint in the body are the movements so free and so varied as in the shoulder joint. This is necessary owing to

the many functions performed by the upper limb. Freedom of movement is provided for in two ways—(1) by the large size of the head of the humerus, in comparison with the small dimensions and shallow character of the glenoid cavity; (2) by the great laxity of the capsule of the joint. These provisions for allowing an extensive range of movement might, at first sight, lead one to doubt the security of the joint. Its strength certainly does not lie in the adaptation of the bony surfaces to each other, nor in the strength of its ligaments. It lies in—

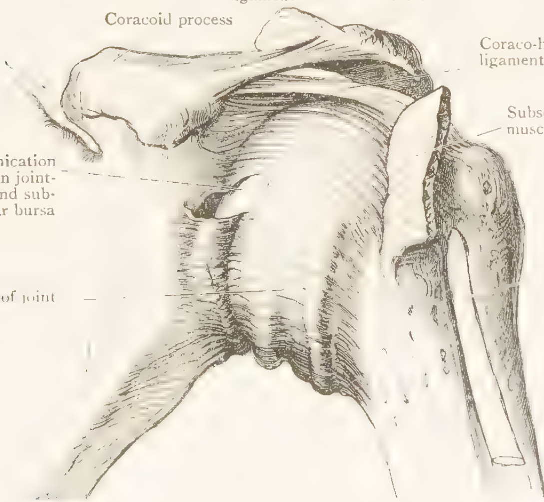


FIG. 46.—Shoulder joint as seen from the front.

(1) the powerful muscles by which it is closely surrounded; (2) the overhanging coraco-acromial arch, which forms, as it were, a secondary socket for the head of the humerus, and effectually prevents upward displacement; and (3) atmospheric pressure, which exercises a powerful influence in keeping the opposed surfaces in contact with each other.

On all aspects, except over a small area below, the capsule is supported by muscles, the tendons of which are more or less adherent to it. *Above*, it is covered by the supraspinatus; *behind*, the infraspinatus and teres minor are applied to it; *in front*, there is the subscapularis which is also below the

capsule near the scapula (Fig. 47). *Below*, the capsule is otherwise unsupported by muscles, and there it bulges downwards, in the form of a fold, in the ordinary dependent position of the limb (Figs. 45, 48). When, however, the arm is abducted, the fold is obliterated, and the head of the bone rests upon the inferior part of the capsule, which now receives partial support from two muscles which are stretched under it, viz., the long head of the triceps and the teres major. Nevertheless, this is the weakest part of the joint; and, consequently, dislocation of the head of the humerus downwards into the axilla, through the inferior part of the capsule, is an occurrence of considerable frequency. When the dislocation occurs, the circumflex vessels and nerve, which lie close to the capsule, may be injured.

Dissection.—The capsule of the shoulder joint was to a large extent exposed by the reflexion of the muscles inserted into the tuberosities of the humerus; and the subscapular bursa has been examined.

To expose the capsule more fully: Cut through the combined tendon of the coraco-brachialis and biceps, and displace the muscles downwards. Cut through the teres major about its middle and the long head of the triceps about one inch below its origin, and turn both muscles aside. Turn aside the reflected subscapularis, supraspinatus, infraspinatus and teres minor muscles, and note whether or not there is an aperture in the capsule between subscapularis and supraspinatus through which the subacromial bursa communicates with the joint.

Re-examine the subscapular bursa, and note that its aperture of communication with the joint is situated near the root of the coracoid process. Thoroughly clean the outer surface of the capsule. Note its laxity, and define its attachments.

Ligaments of the Shoulder Joint.—These are:—

Capsular ligament.	Gleno-humeral ligaments.
Coraco-humeral ligament.	Transverse ligament.

Labrum glenoidale.

The **capsular ligament** is a fairly dense and strong tubular membrane which envelops the joint on all sides. It is attached to the scapula around the margin of the glenoid cavity. But only at the upper part is it attached directly to the bone; elsewhere it blends with the outer surface of a fibro-cartilaginous ring, called the labrum glenoidale, which is attached to the margin of the cavity for the purpose of increasing its depth. Laterally, the capsule is attached to the anatomical neck of the humerus and to the transverse ligament of the shoulder joint, which bridges across

the top of the bicipital groove. The attachment of the upper part of the capsular ligament to the humerus is quite close to the articular surface of the head, but the attachment of the lower part is half an inch or more from the articular surface; consequently, a considerable part of the lower portion of the neck is inside the capsular ligament, and is covered with

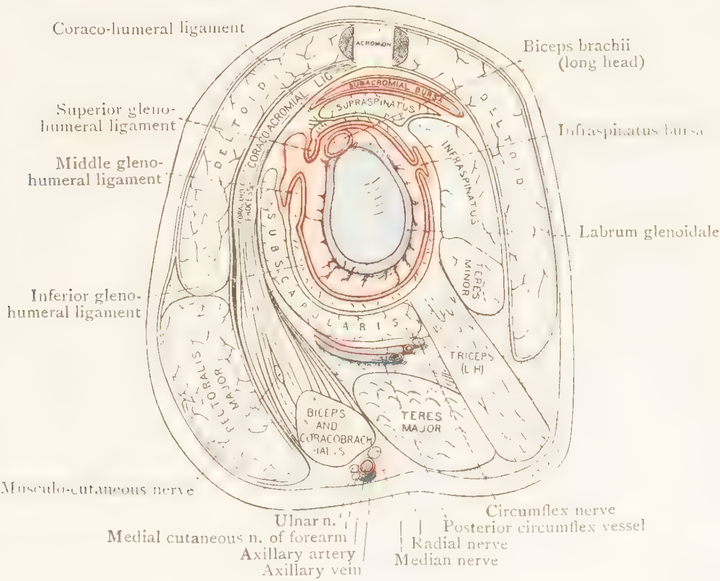


FIG. 47.—Dissection of a sagittal section through the Left Shoulder, (semi-diagrammatic). The subscapular bursa protrudes between the superior and middle gleno-humeral ligaments.

the synovial membrane (Fig. 48). This cannot be seen until the capsule has been opened.

The capsular ligament is not complete at all points. Its continuity is always broken by one aperture and sometimes by two more; and where its lateral margin is attached to the transverse ligament, there is an aperture below the margin. Prolongations of the synovial membrane are protruded through all the apertures.

The largest opening is in the antero-medial part near the root of the coracoid process; and the synovial membrane protrudes through it to form the *subscapular bursa*, which

separates the subscapularis from the front of the capsule and from the front of the neck of the scapula. The dissector should note carefully the size and the position of this opening because, when the joint is dislocated, the head of the humerus is occasionally driven through it, instead of through the lower part of the capsule. It is not often that a second opening is found in the capsule. It is situated, when present,

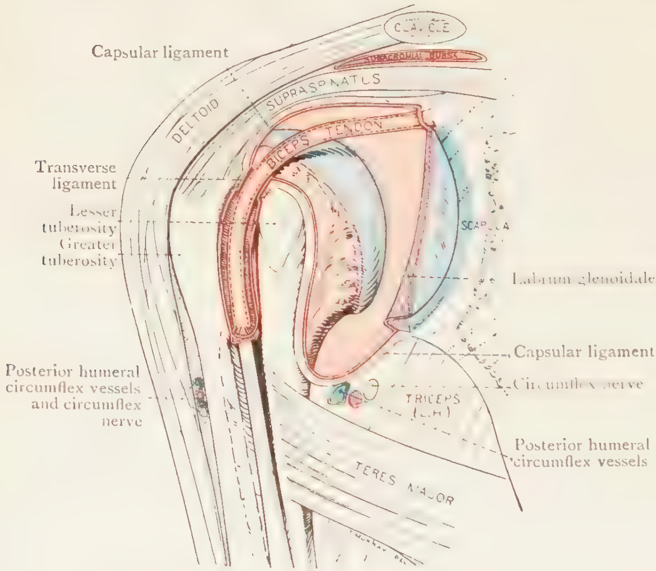


FIG. 48.—Diagram of a Coronal Section of the Right Shoulder. (Viewed from the front. Cf. Fig. 45.)

in the postero lateral part of the capsule and permits the protrusion of the synovial membrane to form a bursa under cover of the infraspinatus muscle (Fig. 47). Still more rarely, the subacromial bursa communicates with the cavity of the joint through an opening opposite the interval between the supraspinatus and subscapularis muscles.

The aperture below the transverse ligament, at the top of the bicipital groove, transmits the tendon of the long head of the biceps ; the tendon is enclosed in a tubular prolongation of the synovial membrane which surrounds it and lines the bicipital groove (Fig. 48).

In four situations the capsular ligament is thickened by bands of fibres which pass from the scapula to the humerus. One of the thickenings—the *coraco-humeral ligament*—can be seen from the exterior. The other three—the *gleno humeral ligaments*—can be seen only from the interior.

The **coraco-humeral ligament** is placed on the upper surface of the joint. It is a broad band of great strength which is more

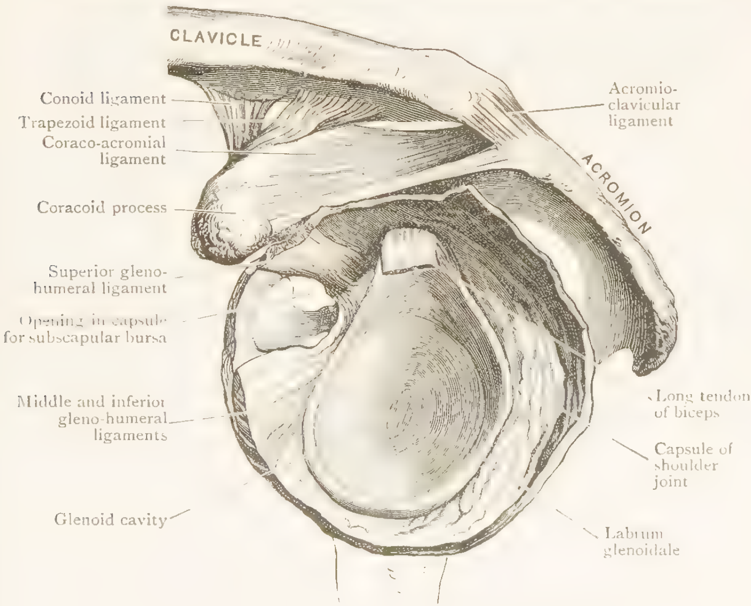


FIG. 49.—Left shoulder joint. The Articular Capsule has been cut across and the Humerus removed.

or less completely incorporated in the capsule. Superiorly, it is fixed to the lateral border of the root of the coracoid process, and it passes thence, obliquely downwards and laterally, to gain attachment to the two tuberosities of the humerus and to the transverse ligament. The pectoralis minor occasionally sends a slip through the coraco-acromial ligament to fuse with the coraco-humeral ligament and, through it, to gain attachment to the humerus.

The *gleno-humeral ligaments* are not important. They are three thickenings of the anterior part of the capsular liga-

ment, and may be thick enough to bulge into the joint, raising up ridges of synovial membrane.

The **transverse ligament** of the shoulder joint is an important retinaculum that holds the tendon of the long head of the biceps in place in the upper part of the bicipital groove. It is attached to the two tuberosities of the humerus, and bridges across the bicipital groove as far down as the level of the epiphyseal line.

The *relations* of the capsule are shown in Figs. 47, 48.

Dissection.—Make a vertical incision through the posterior part of the capsule. Turn the head of the humerus aside, and note if the gleno-humeral ligaments make their presence seen. Then, complete the division of the capsule, cut the long tendon of the biceps, and pull the humerus and scapula apart.

The **labrum glenoidale** is the dense, fibro-cartilaginous band which surrounds the margin of the glenoid cavity, and is attached to its rim. It deepens and widens the articular socket. Its intimate connexion with the capsule of the joint can now be studied. Two tendons also are closely associated with it, viz., the long head of the triceps below, and the long head of the biceps above.

The *tendon of the long head of the biceps* is an important factor in the mechanism of the shoulder joint. Traced from below, it enters the joint through the opening between the two tuberosities of the humerus, and is prolonged over the head of the bone to the apex of the glenoid cavity. Its attachment to the scapula should now be examined. The tendon divides into three portions, viz. a large middle part, which obtains direct attachment to the scapula, and two smaller collateral parts, which diverge from each other and blend with the labrum glenoidale. The long head of the biceps brachii, by its position within the capsule and in the deep sulcus between the tuberosities of the humerus, serves to keep the head of the bone in place, and to steady it in the various movements at the shoulder joint.

Synovial Membrane.—The synovial membrane lines the capsular ligament, and is reflected from it upon the neck of the humerus as far as the articular margin of the head. Its protrusion to form the *subscapular bursa* has already been noticed. The tendon of the biceps, as it traverses the joint, is enveloped in a sheath of the membrane; this sheath passes out with the tendon and lines the bicipital groove (Fig. 48).

PLATE III

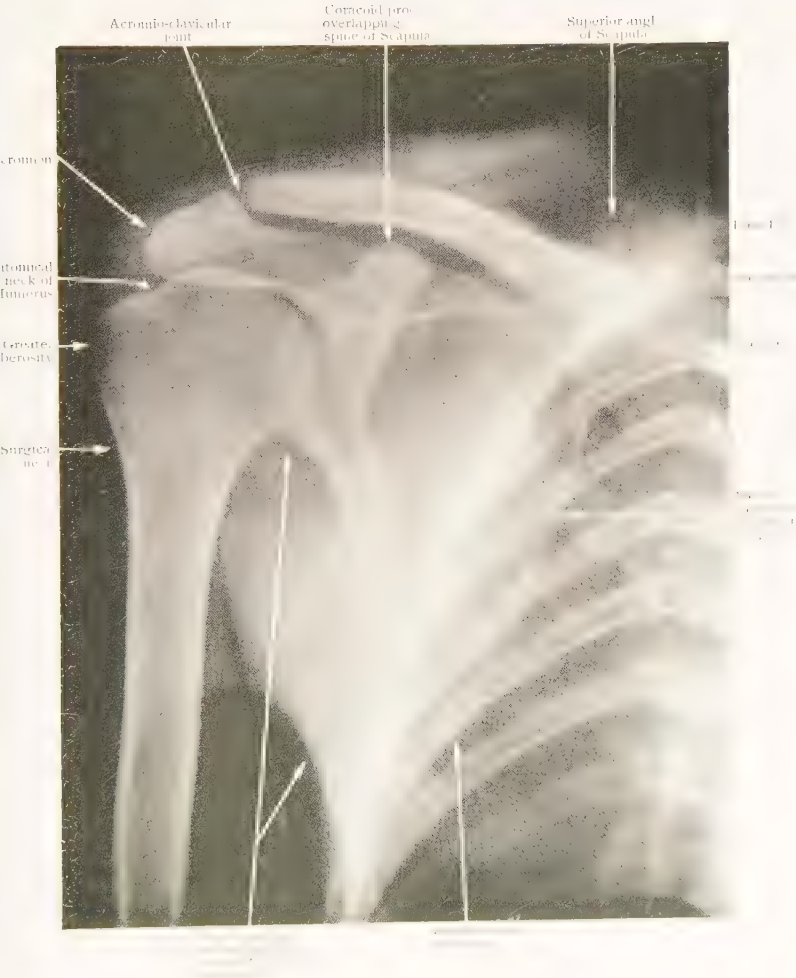


PLATE IV

FIG. 51A. Radiograph of Shoulder of young man aged 18. Note the positions of Scapula and head of Humerus.

FIG. 51B. – Radiograph of same Shoulder – arm abducted to right angle. Note the change in positions of Scapula and head of Humerus.

PLATE V

[illegible] and raised above the head. Note that the rotation of the Humerus [illegible] continued until the shaft is in line with the spine of the Scapula; note the further movement of the Scapula itself.

PLATE VI

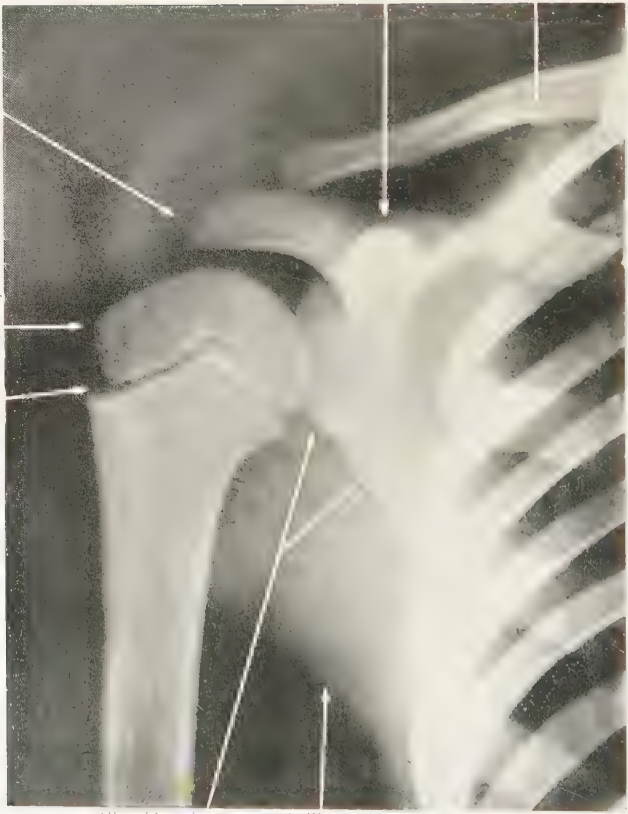


FIG. 53. Radiograph of Shoulder Region of boy aged

(Dr. J. Duncan White.)

Note that the proximal epiphysis of the Humerus (formed by union of centres for head, greater (and sometimes lesser) tuberosity) fits like a cap on end of shaft. Cf. Figs. 51 and

Articular Surfaces.—The articular cartilage which coats the head of the humerus is thickest in the centre, and thins as it passes towards the edges. In the glenoid cavity the reverse of this will be seen, if the cartilage is incised.

Movements at the Shoulder Joint.—The shoulder is a ball-and-socket joint, and consequently movement in every direction is permitted, viz.—(1) *flexion*, or forward movement; (2) *extension*, or backward movement; (3) *abduction*; (4) *adduction*. By combination of the angular movements, *circumduction* is produced. *Rotation* of the humerus, to the extent of quarter of a circle, occurs also.

The **muscles** concerned are:—*Flexion*—pectoralis major, coraco brachialis and anterior part of deltoid. *Extension*—latissimus dorsi, posterior part of deltoid, and teres major. *Abduction*—deltoid and supraspinatus. *Adduction*—pectoralis major, coraco-brachialis, teres major, and latissimus dorsi. *Circumduction*—by the action of different combinations of these muscles. *Rotation medially*—subscapularis, pectoralis major, latissimus dorsi, teres major. *Rotation laterally*—infraspinatus, and teres minor.

The muscles inserted into the tuberosities act mainly in steadying and preventing displacement of the head of the humerus; while the main effectors of movement are inserted farther from the joint.

The range of movement of the limb as a whole depends upon movements of the shoulder girdle which are invariably associated with movements at the shoulder joint. In abducting the arm to the horizontal position, for example, and then raising it above the head, it is not the case that the humerus moves only in the first phase and the scapula in the second. The movements at shoulder joint and of shoulder girdle are associated throughout (Cathcart). Radiographs taken in different phases of the action (Figs. 51, 52) demonstrate this association, and it has been shown that there is continuous movement of the scapula in the chest wall, and of the humerus at the shoulder joint (R. D. Lockhart). The movement of the humerus includes considerable lateral rotation (C. P. Martin).

FOREARM AND HAND

The skin has been removed; the cutaneous veins and nerves have been dissected; and the deep fascia must now be removed. But, before proceeding to do so, the dissector will re-read the accounts already given of:—

1. The surface anatomy of the forearm and hand (p. 69).
2. The cutaneous veins (p. 72).
3. The cutaneous nerves (p. 81).
4. The deep fascia of the elbow, forearm and hand (p. 87).

Front and Medial Border of Forearm

In this dissection the structures to be displayed are:—

1. The radial and ulnar arteries and their branches.
2. The median and ulnar nerves and their branches.
3. The radial nerve and part of the posterior interosseous nerve.
4. The group of pronator and flexor muscles.

Dissection.—Make two incisions through the deep fascia: (1) a transverse incision at the upper border of the flexor retinaculum; (2) a longitudinal incision from the apex of the cubital fossa to the transverse incision.

As the transverse incision is made be careful not to injure the palmar cutaneous branches of the median and ulnar nerves, the tendon of the palmaris longus, the ulnar nerve and artery, and the synovial sheaths of the flexor tendons (all of which lie immediately subjacent to the deep fascia).

Turn the two flaps to the sides, dividing the septa which pass

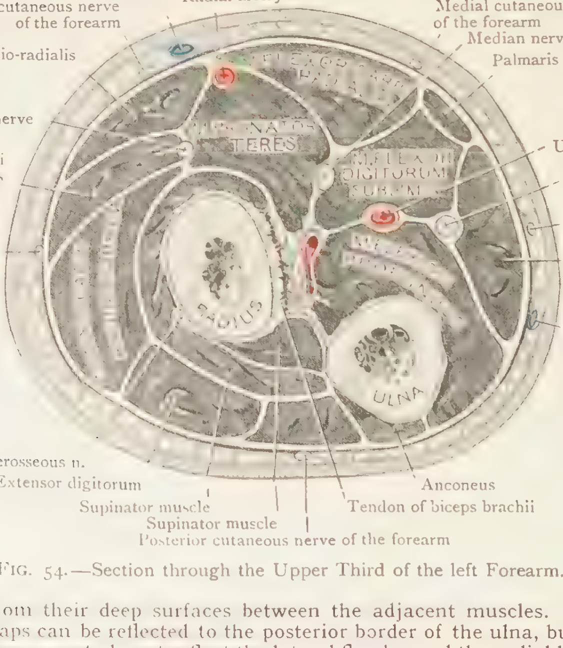


FIG. 54.—Section through the Upper Third of the left Forearm.

from their deep surfaces between the adjacent muscles. Both flaps can be reflected to the posterior border of the ulna, but, for the present, do not reflect the lateral flap beyond the radial border of the forearm. Near the elbow, where the muscles gain additional origin from the fascia, leave the fascia *in situ*, for attempts to remove it will result only in laceration of the muscles.

Muscles of the Front of the Forearm.—These muscles are the flexors of the wrist and digits and the pronators of the forearm, and are arranged in a superficial and a deep group.

In the *superficial group*, there are the brachio-radialis, the pronator teres, the flexor carpi radialis, the palmaris longus,

and the flexor carpi ulnaris (in that order from the lateral to the medial side), and also the flexor digitorum sublimis, which, however, is in a deeper plane, and comes to the surface only partially.

Identify these muscles at once. The brachio-radialis lies along the lateral border of the forearm; it extends from the lateral supra-condylar ridge of the humerus to the distal end of the radius. The other muscles extend from the medial epicondyle. The pronator teres ends at the middle of the radius. The flexor carpi radialis passes to the medial part of the ball of the thumb, and disappears there. The palmaris longus lies close along the medial side of the flexor carpi radialis. The flexor carpi ulnaris descends along the medial border of the forearm to the pisiform bone. The main part of the flexor digitorum sublimis is under cover of the other muscles, but, in the distal part of the forearm, part of it appears between the palmaris longus and the flexor carpi ulnaris.

The *deep group* is composed of three muscles, placed in contact with the bones and interosseous membrane, viz., the flexor digitorum profundus, in relation to the ulna, the flexor pollicis longus, in relation to the radius, and the pronator quadratus, closely applied to the distal ends of both bones.

Dissection.—Clean the brachio-radialis from end to end. Two muscles overlie its distal part the abductor pollicis longus and extensor pollicis brevis. Push them aside, taking care not to injure the radial nerve. Having cleaned the brachio-radialis, pull it aside and clean the radial nerve and the radial artery and its branches.

Radial Artery. This is the smaller of the two terminal branches of the brachial artery, but its direction gives it the appearance of being the continuation of the parent trunk in the forearm. It takes origin in the cubital fossa, opposite the neck of the radius, and it descends, in the lateral part of the front of the limb, until it reaches the distal end of the radius. There, it turns round the lateral border of the wrist and leaves the present dissection. At first, it lies between the pronator teres and the brachio-radialis, and is overlapped to a variable extent on the lateral side by the fleshy belly of the brachio-radialis (Fig. 57). Lower down, the brachio-radialis is on its lateral side, and the flexor carpi radialis on its medial side; and so remain as far as the wrist. Where the muscles mentioned are fleshy, the artery lies at some depth from the surface; but when their tendons appear, it assumes a super-

ficial position, and is covered merely by the skin and the fasciæ. Throughout its whole length it is closely accompanied by *venæ comitantes*. The radial nerve lies along its lateral side in the middle third of the forearm; higher up, the nerve is separated from the vessel by a slight interval; whilst distally, the nerve leaves the artery and turns round the lateral margin of the forearm, under cover of the tendon of the brachio-radialis.

Posteriorly, the radial artery rests chiefly on the muscles which clothe and find attachment to the front of the radius. At its origin, it rests upon the tendon of the biceps brachii; next, it lies in front of the supinator, with some adipose tissue intervening; thence downwards, it is in contact with the pronator teres, the radial head of the flexor digitorum sublimis, the flexor pollicis longus, the pronator quadratus, and, lastly, the distal end of the radius.

The radial artery is usually selected for the determination of the *pulse*. When the tips of the fingers are placed upon the distal part of the forearm, a little lateral to the tendon of the flexor carpi radialis, the pulsations of the vessel, in the living person, can readily be felt.

Branches of Radial Artery in the Forearm.—These are:—

1. Radial recurrent.	3. Anterior carpal.
2. Superficial palmar.	4. Muscular.

The *muscular branches* are very numerous, and proceed from the radial artery, at irregular points, throughout its whole course in the forearm (Fig. 58).

The *radial recurrent artery* is a branch of some size that takes origin close to the commencement of the radial artery. It runs first laterally and then upwards, and ends, in front of the lateral epicondyle, by anastomosing with the anterior branch of the profunda brachii artery. It may be represented by two or more vessels.

The *superficial palmar artery*, small and variable, arises a short distance above the wrist, and ends in the thenar muscles. Sometimes, however, it attains a larger size and is continued into the palm to join the lateral end of a transverse artery called the superficial palmar arch.

The *anterior carpal artery* is a small twig that runs medially on the distal end of the radius.

Radial and Posterior Interosseous Nerves.—The *posterior interosseus nerve* springs from the radial immediately above the level of the capitulum of the humerus, descends in

front of the elbow joint under cover of the brachio-radialis, gives branches to the extensor carpi radialis brevis and the supinator, and then disappears into the supinator to re-appear in the back of the forearm.

The **radial nerve** leaves the upper arm by descending across the front of the elbow joint opposite the capitulum of the humerus, and enters the forearm. In the forearm, it lies for a great part of its course under cover of the brachio-radialis, coming into relation with the lateral side of the radial artery in the middle third of the forearm. In the distal third, it leaves the artery, inclines backwards, appears at the posterior border of the tendon of the brachio-radialis, pierces the deep fascia about two inches above the wrist, and descends across the abductor pollicis longus and extensor pollicis brevis, into the hand, where it has been examined already. It gives off no branches in the forearm.

Dissection. Before you begin to clean the superficial flexor muscles, make an attempt to demonstrate the synovial sheaths of the flexor tendons ; their upper parts are under cover of the deep fascia in the lowest inch of the forearm. They are the common sheath of the flexors digitorum sublimis and profundus, the sheath of the flexor pollicis longus and the sheath of the flexor carpi radialis.

If the sheaths are uninjured they can be distended with air by means of a blowpipe, or by liquid forced in through a syringe. If they have been injured, explore them with a blunt probe.

Examine, first, the common sheath of the flexor tendons of the fingers. Pick up a fold of the medial part of its anterior wall with the forceps, and introduce the blowpipe or the needle of the syringe into the base of the fold. As the air or liquid enters the sheath, note that it is distended at first upwards as far as an inch above the flexor retinaculum. Then, the distension passes downwards, behind the retinaculum to the middle of the palm and along the little finger, as far as the terminal phalanx.

The sheath of the flexor carpi radialis is not easily distended, because it is enclosed for the greater part of its extent in an osteo-fibrous canal. Open it at the upper border of the retinaculum and investigate it with a blunt probe.

Pull the tendon of the flexor carpi radialis medially, find the tendon of the flexor pollicis longus behind it, and either distend its sheath in the manner indicated or examine it with a probe.

Synovial Sheaths of the Flexor Tendons. As the tendons of the flexor digitorum sublimis, the flexor digitorum profundus, and the flexor pollicis longus pass behind the flexor retinaculum (transverse carpal ligament) they are accompanied by the median nerve and they are enveloped in two sheaths (Fig. 56). One sheath surrounds the flexor pollicis longus ;

the other surrounds the tendons of both the flexor sublimis and the flexor profundus, and it may enclose also the median nerve. The sheaths, therefore, line a "carpal tunnel" which

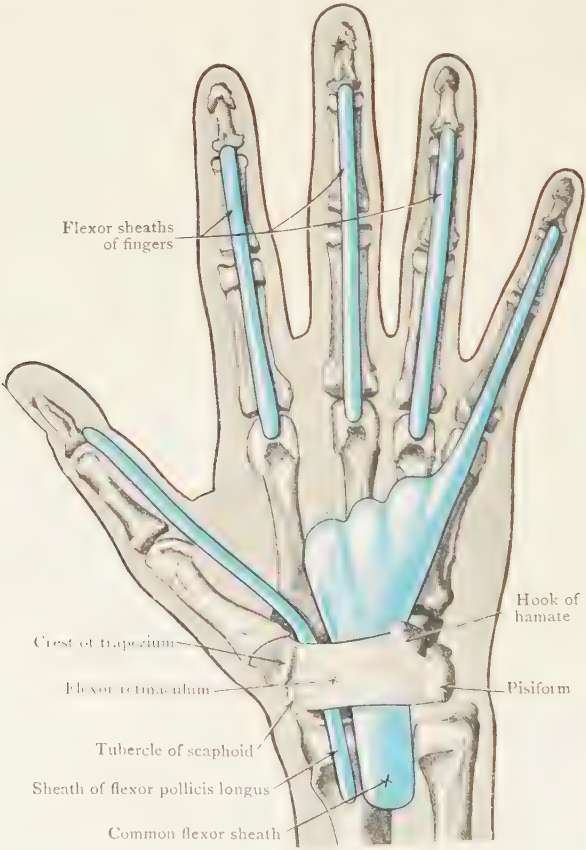


FIG. 55.—The Synovial Sheaths of the Flexor tendons of the Digits.

is bounded by the flexor retinaculum and the carpal bones, and they greatly facilitate the free play of the tendons in that tunnel. Both sheaths are prolonged into the forearm for one inch or more, and both are carried into the palm on the diverging tendons. The portion in relation to the tendons

which go to the index, middle, and ring fingers ends near the middle of the palm. The portion related to the tendons of the little finger and the sheath of the flexor pollicis longus are prolonged into the digits as far as the base of the terminal phalanx, and line the fibrous flexor sheaths (Fig. 55).

The synovial sheath which invests the tendons of the flexor digitorum sublimis and flexor digitorum profundus is sometimes divided by a vertical partition into two compartments, and the lateral of them communicates, by means of a small aperture near the upper border of the flexor retinaculum, with the sheath of the tendon of the flexor pollicis longus.

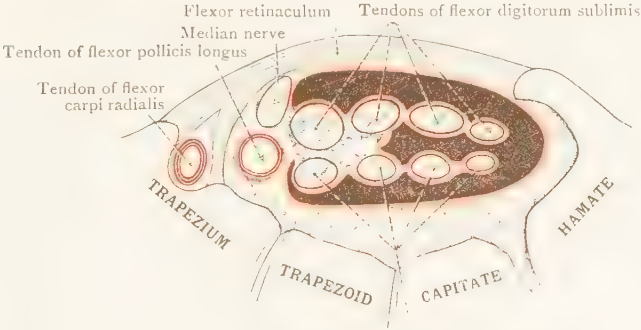


FIG. 56.—Diagram of Synovial Sheaths behind Flexor Retinaculum.

The Constitution of Synovial Sheaths of Tendons.—The student should understand the nature of synovial sheaths which surround tendons, where they pass through fascial or osteo-fascial canals. The majority of the synovial sheaths are double walled tubes. At their extremities, the outer and inner walls are bound together, and the space between the two walls the so called cavity of the sheath is thus closed. The cavity of the sheath is a capillary space only, and it contains merely sufficient synovia to lubricate the adjacent surfaces, and facilitate their free play over one another.

The inner wall of the tube surrounds the tendon and adheres to its surface. The outer wall lines the canal through which the tendon passes, and adheres to it. But the ends of the sheaths project beyond the limits of the canals which they line; therefore, as the tendons move upwards and downwards, the opposite ends of the sheaths can be invaginated

and evaginated, thus allowing for the free play of the tendons. The sheath of the flexors of the fingers is an invaginated sac rather than a tube (Fig. 56).

When a sheath becomes inflamed the adjacent surfaces of its two walls are at first roughened, and when the tendon moves, friction occurs, which can be heard and felt, and pain is caused. Then the fluid between the two walls increases in amount, the sheath becomes distended as if it had been injected, and its position becomes apparent. At the same time the friction ceases, but the distension of the walls stretches the nerves, and pain is still felt.

Dissection.—Clean the muscles that arise from the medial epicondyle, and be careful not to damage their nerves.

Begin with the *pronator teres*. Clean it from end to end, pushing aside the muscles that cover its insertion. As you clean its lower part, be careful not to injure the radial origin of the flexor digitorum sublimis, which lies behind it. Separate the pronator teres from the flexor carpi radialis. Cut the head of the pronator that arises from the medial epicondyle. Turn the lower part downwards and find the deep head—a slender slip—and follow it upwards to the coronoid process.

Clean the *flexor carpi radialis* down to the flexor retinaculum; and clean the *palmaris longus* down to its insertion into the palmar aponeurosis. (The palmaris longus is sometimes absent.)

Now, clean the *flexor carpi ulnaris*—first down to the pisiform bone, and then upwards. Note that, besides the part that arises from the epicondyle, it has a thin, wide head that arises from the ulna; find the ulnar nerve between the two heads at the elbow. Separate the flexor carpi ulnaris from the palmaris longus and flexor digitorum sublimis, and find the *ulnar nerve* in the uppermost part of the forearm; secure its branches to the flexor carpi ulnaris and flexor digitorum profundus. Trace the ulnar nerve to the wrist and secure the cutaneous branches (dorsal branch and palmar cutaneous branch, p. 84) that arise from it in the lower half of the forearm. Clean the lower half of the *ulnar artery* (and its branches) as far as the wrist; its carpal branches, given off near the wrist, are very liable to injury.

To get a good view of the flexor digitorum sublimis:—Divide the palmaris longus and the flexor carpi radialis at the middle of the forearm. Turn their proximal parts upwards and separate them from the pronator teres and the flexor sublimis by splitting the intervening intermuscular septa. Pull the pronator teres laterally and secure the median nerve as it emerges between its heads and before the nerve disappears behind the flexor digitorum sublimis. Then clean the flexor sublimis, being careful not to injure the part of it that arises from the radius. Clean the four tendons in which the flexor sublimis terminates. Pull upon the tendons and note the results. Do not follow them farther than the flexor retinaculum at present.

Superficial Muscles.—The five muscles of the superficial group are closely associated with each other at the elbow—

indeed, they arise by a **common origin** from the front of the medial epicondyle. In addition, they all derive fibres from the investing deep fascia near the elbow, and from the septa between them. The pronator teres, the flexor sublimis, and the flexor carpi ulnaris, have additional heads of origin (Figs. 57, 58).

The **pronator teres** muscle crosses the proximal half of the front of the forearm obliquely. It arises by two heads.

The *humeral head* constitutes the chief bulk of the muscle. It springs from the medial epicondyle and from the distal part of the medial supracondylar ridge. The *ulnar head* is a small slip placed deeply, and it may be recognised from the fact that it intervenes between the median nerve and the ulnar artery. It arises from the medial border of the coronoid process of the ulna (Fig. 60, p. 145), and soon joins the deep surface of the humeral head.

The muscle, thus formed, descends obliquely and ends in a tendon which gains insertion into a rough impression on the middle of the lateral surface of the radius (Fig. 64). This attachment is on the summit of the chief curve of the radius—an arrangement which enables the muscle to exercise its pronating action at great advantage.

Close to its insertion the pronator teres is crossed by the radial artery and it is covered by the brachio-radialis and the extensor carpi radialis longus muscles. It is supplied by the *median nerve*. It is a pronator and flexor of the forearm.

The **flexor carpi radialis** arises chiefly from the medial epicondyle. Its fleshy belly gives place, a short distance below the middle of the forearm, to a long tendon, which, at the wrist, traverses the groove on the front of the os trapezium, in a special compartment at the lateral end of the flexor retinaculum (Fig. 56, p. 135). It is inserted chiefly into the base of the metacarpal bone of the index. Its relations to the flexor retinaculum, and also its insertion, will be exposed and studied at a later stage of the dissection.

It is a flexor of the wrist and elbow, and an abductor of the hand. It is supplied by the *median nerve*.

The **palmaris longus** is a long slender muscle which is not always present. It springs from the medial epicondyle. Its tendon pierces the deep fascia immediately above the wrist, and then crosses the flexor retinaculum (adhering to the front of the retinaculum) to be inserted into the apex

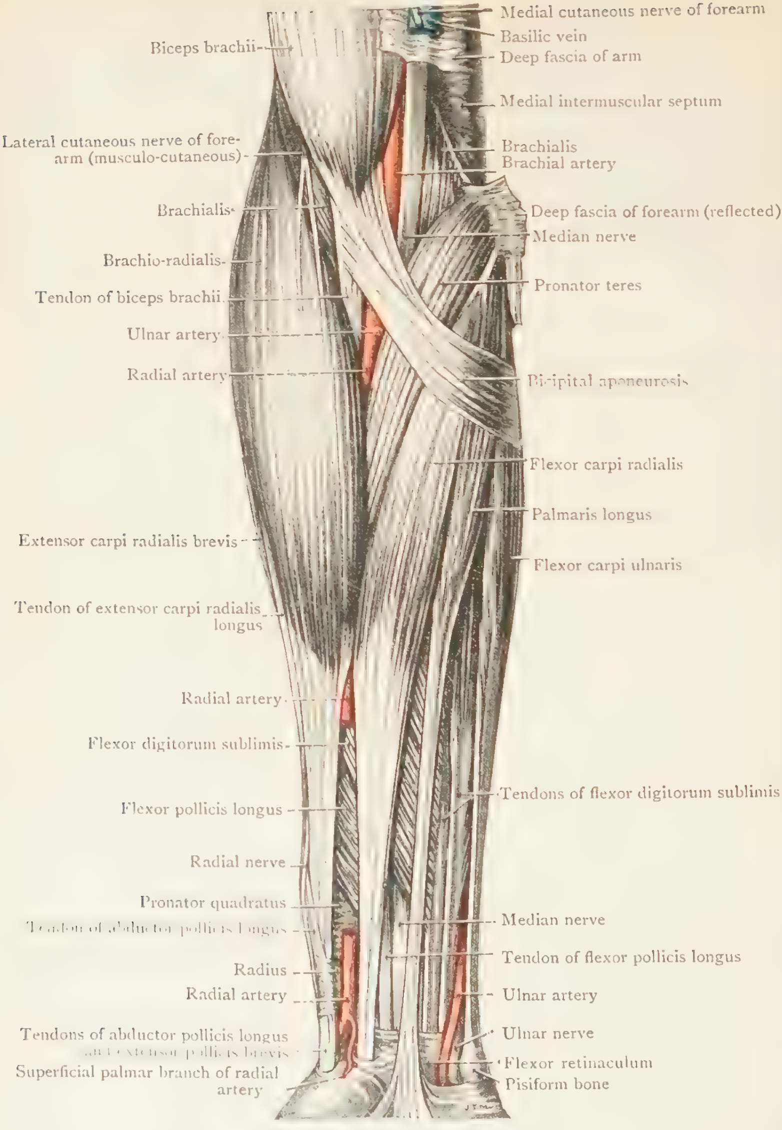


FIG. 57.—Dissection of the Superficial Muscles, Arteries, and Nerves of the front of the Forearm.

Part of the radial artery was removed to show some of its deep relations.

of the palmar aponeurosis. Very frequently it gives a slip to the abductor pollicis brevis. It is supplied by the *median nerve*, and is a flexor of the wrist and elbow joints.

The **flexor carpi ulnaris** arises by two heads. The *humeral head* arises from the medial epicondyle. The *ulnar head* arises from the olecranon and, by a wide *aponeurosis*, from the upper two-thirds of the posterior border of the ulna. The two heads of origin bridge across the interval between the medial epicondyle and the olecranon, and between them the ulnar nerve passes into the forearm. The tendon appears on the anterior border of the muscle, and is inserted into the pisiform bone.

The flexor carpi ulnaris is supplied by the *ulnar nerve*. It is a flexor and adductor of the hand and a flexor of the elbow.

The **flexor digitorum sublimis** receives this name because it is placed on the superficial aspect of the flexor profundus. For the most part it lies deeper than the other superficial muscles (Fig. 57). It is a powerful muscle which arises by two heads. The *humero-ulnar head* arises chiefly from the medial epicondyle and the coronoid process. The *radial head* is a thin sheet that arises from the upper half of the anterior border of the radius (Fig. 60).

Four tendons issue from the fleshy mass; they enter the palm by passing under cover of the flexor retinaculum, and go to the medial four digits to be inserted into the middle phalanx. Their insertions will be seen later; but, in the meantime, note that, for an inch above the wrist, they are enveloped by the synovial sheath, and also that they lie in pairs—the tendons to the ring and middle fingers being placed in front of those for the index and little fingers.

The flexor digitorum sublimis is supplied by the *median nerve*. It is a flexor of the first interphalangeal joints of the fingers, the metacarpo-phalangeal joints, the wrist joint, and, very slightly, the elbow joint.

Dissection.—Cut through the radial part of the flexor digitorum sublimis at its union with the humeral portion. Pull the main mass of the muscle towards the medial side of the forearm, and turn the radial portion towards its origin. The median nerve adheres to the deep surface of the flexor sublimis, and will be turned aside with it. Trace the nerve downwards, and secure its palmar cutaneous branch near the wrist.

Clean the flexor pollicis longus and the flexor digitorum profundus, taking care of their nerves.

Return to the median nerve in the cubital fossa. Trace its branches to neighbouring muscles. Follow it downwards and secure the anterior interosseous nerve, which springs from the median as it passes between the heads of the pronator teres. Find the *common interosseous artery*, which arises from the ulnar an inch below its origin, and soon divides into the anterior and posterior interosseous arteries. The posterior branch passes backwards out of this dissection. Separate the flexor pollicis and flexor profundus, and trace the *anterior interosseous artery* and *nerve* downwards to the pronator quadratus -taking care of the branches of the nerve.

Clean the pronator quadratus ; and then study the structures exposed.

Ulnar Artery.—This is the larger of the two terminal branches of the brachial trunk. It takes origin, in the cubital fossa, at the level of the neck of the radius. In the upper third of the forearm it passes obliquely downwards and medially, and then it proceeds straight down to the wrist. It pierces the deep fascia immediately above the flexor retinaculum, and passes on to the front of it, where it gives off a *deep branch* and then becomes the *superficial palmar arch*.

In the upper, oblique portion of its course, the vessel is deeply placed, and is crossed by both heads of the pronator teres, the flexor carpi radialis, the palmaris longus, the flexor digitorum sublimis and the median nerve. Its lower, vertical part is overlapped on the medial side by the flexor carpi ulnaris, but a short distance above the wrist it comes nearer the surface, and lies behind the deep fascia in the interval between the tendon of the flexor carpi ulnaris and the tendons of the flexor sublimis. As it lies on the flexor retinaculum, it is separated from the pisiform bone by the ulnar nerve, and is sometimes crossed by a slip of fascia that passes from the superficial surface of the retinaculum to the front of the pisiform bone. Throughout its entire course it is accompanied by two *venæ comitantes*. It has important relations to the median and ulnar nerves. The *median nerve*, which lies on its medial side at its origin, soon crosses it, but at the point of crossing the nerve is separated from the artery by the deep head of the pronator teres. The *ulnar nerve*, in the upper third of the forearm, is separated from the vessel by a V-shaped interval ; but, in the lower two-thirds, it lies close along the medial side of the artery.

In the cubital fossa, the ulnar artery rests on the brachialis ; from there to the wrist, it lies on the flexor digitorum profundus ; at the wrist, it lies on the flexor retinaculum.

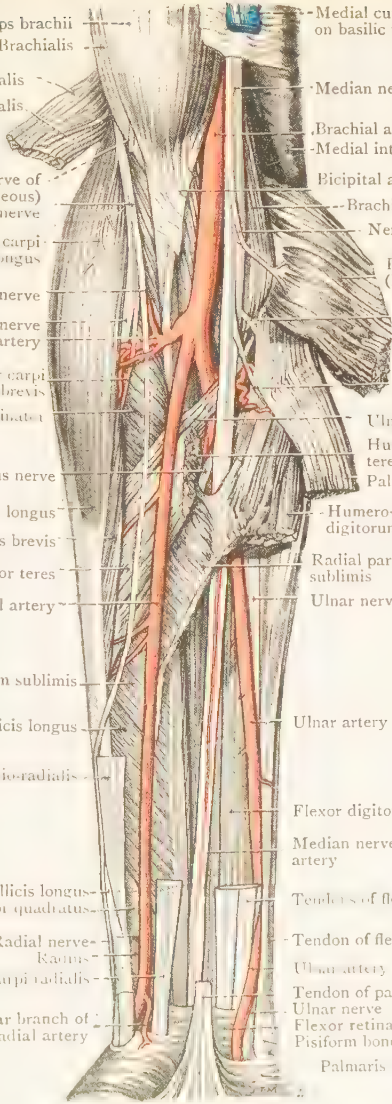


FIG. 58.—Deep Dissection of the Muscles, Vessels, and Nerves of the front of the Forearm. The division of the brachial artery is slightly lower than usual.

Branches of Ulnar Artery in the Forearm.—These are :—

1. Anterior ulnar recurrent.	4. Anterior carpal.
2. Posterior ulnar recurrent.	5. Posterior carpal.
3. Common interosseous.	6. Muscular.

The *muscular branches* are of small size, and come off at variable points for the supply of the neighbouring muscles.

The **recurrent arteries** arise near the elbow, either separately or by a common stem, and ascend among the muscles to the front and back of the medial epicondyle, where they anastomose with branches of the brachial artery.

The **common interosseous artery** is a short, wide trunk which takes origin below the recurrent branches, about one inch from the commencement of the ulnar artery. It passes backwards to the upper margin of the interosseous membrane, where it divides into two terminal branches, viz., the *anterior* and the *posterior interosseous arteries.*

The **posterior interosseus artery** passes backwards above the interosseous membrane to the back of the forearm, where it will be dissected at a later period.

The **anterior interosseous artery** descends over the front of the interosseous membrane, between the flexor pollicis longus and the flexor digitorum profundus. At the upper border of the pronator quadratus, it pierces the interosseous membrane and passes to the back of the forearm, where it will be seen later. As it descends in the front of the forearm it gives off :—(1) *muscular* twigs ; (2) *nutrient* arteries to the radius and the ulna ; (3) the *median* artery—long and slender—which accompanies the median nerve ; and (4) a *communicating* branch that descends behind the pronator quadratus to anastomose with the anterior carpal arteries.

The carpal branches of the ulnar artery are small arteries that arise near the wrist. The **anterior carpal artery** curves backwards round the medial side of the flexor profundus, and then runs laterally over the front of the distal end of the radius. The **posterior carpal artery** passes backwards above the pisiform bone, behind the flexor carpi ulnaris, to gain the back of the carpus.

Ulnar Nerve.—The ulnar nerve arises in the axilla from the medial cord of the brachial plexus, descends through the medial part of the upper arm to the back of the medial epicondyle, and passes between the heads of the flexor carpi ulnaris to enter the forearm.

It descends in the medial part of the front of the forearm, lying upon the flexor digitorum profundus, under cover of the flexor carpi ulnaris. Near the pisiform bone, it pierces the deep fascia at the lateral side of the flexor carpi ulnaris, and

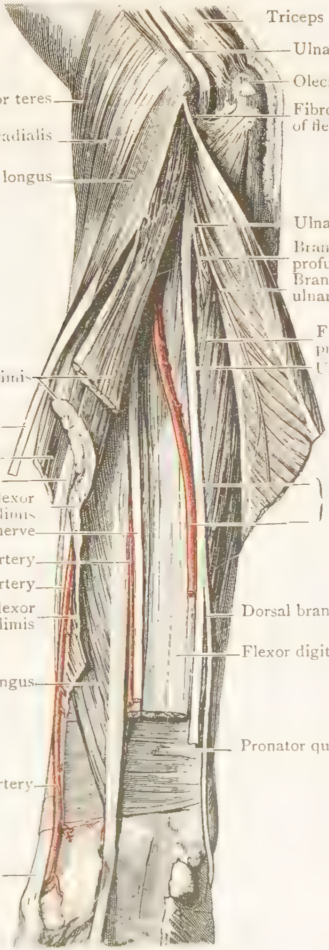


FIG. 59.—Deep dissection of the front of the Forearm. The superficial muscles are cut short and turned aside. The deeper parts are still further displayed by the separation of the flexor digitorum sublimis from the flexor carpi ulnaris.

leaves the forearm by passing on to the front of the flexor retinaculum; and it ends on the retinaculum by dividing into two terminal branches—a superficial and a deep.

At the elbow, the ulnar nerve is separated from the ulnar artery by a wide interval; but, as they descend in the upper third of the forearm, the artery approaches the nerve, and, in the lower two-thirds, is closely applied to its lateral side.

The ulnar nerve gives off no branches till it reaches the forearm, where the following branches arise from it:—

1. *Articular branches* which arise in the interval between the olecranon and the medial epicondyle, and pass to the capsule of the elbow joint.
2. *Muscular branches* to the flexor carpi ulnaris and the medial half of the flexor digitorum profundus which arise near the elbow.
3. The *dorsal branch* to the skin of the medial part of the back of the hand and to the little and ring fingers (p. 84).
4. The *palmar cutaneous branch* to the skin of the medial part of the palm (p. 84).

It has been noted (p. 107) that the ulnar nerve may contain fibres derived from the seventh cervical nerve. These fibres may reach it either through a slender contribution from the lateral cord of the brachial plexus which joins it in the axilla by passing behind the medial root of the median nerve, or through a communication from the median nerve in the forearm.

Median Nerve.—The median nerve receives its name because it passes down the middle of the forearm. Most other structures named "median" are in the median plane.

The median nerve arises in the axilla by two roots that spring from the lateral and medial cords of the brachial plexus. It descends through the upper arm, at first on the medial side and then on the front, and passes in front of the elbow joint into the forearm. It descends through the middle of the front of the forearm behind the flexor digitorum sublimis adhering to the deep surface of that muscle. An inch or more above the crease at the wrist, it escapes from behind the flexor sublimis, curves forwards round the lateral side of its tendons on to the front of them, and descends with them, into the carpal tunnel behind the flexor retinaculum; and it ends behind the retinaculum, near its distal border, by dividing into two terminal branches—a lateral and a medial.

In the cubital fossa, the median nerve lies in front of the brachialis at the medial side of the ulnar artery. It leaves the fossa by passing between the two heads of the pronator teres, and as it does so it crosses in front of the

ulnar artery, but is separated from it by the ulnar head of the muscle. From that point the median nerve runs between the flexor digitorum sublimis and the flexor digitorum profundus. Near the wrist, after it has wound round the lateral side of the sublimis tendons on to the front of them, it lies opposite the interval between the tendons of the palmaris longus and flexor carpi radialis (Fig. 57).

Like the ulnar nerve, the median nerve gives off no branches in the axilla or in the upper arm. In the cubital fossa, it sends branches from its medial side to four muscles, namely, *pronator teres*, *flexor carpi radialis*, *palmaris* and *flexor digitorum sublimis*. As it leaves the fossa, it gives off the

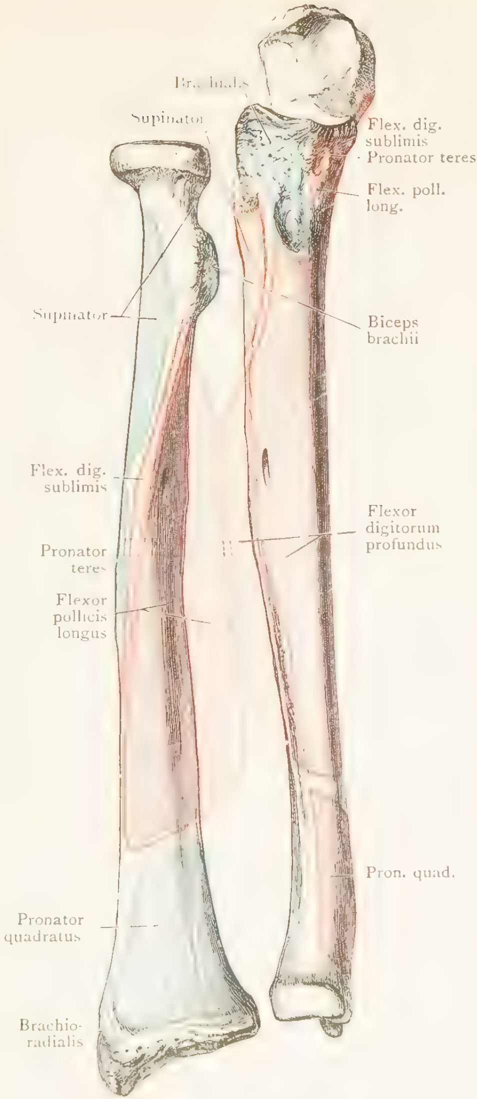


FIG. 60.—Front of Bones of Forearm with Muscular Attachments mapped out.

anterior interosseous nerve. Near the wrist, its *palmar cutaneous branch* springs from it (p. 83).

Dissection.—The *anterior interosseous nerve* has been traced down to the pronator quadratus. Now, divide the *pronator quadratus* by a vertical cut through its middle, and turn the two parts aside. Secure the branches that the anterior interosseous nerve gives to the muscle, and then trace the nerve down to the front of the wrist joint.

Examine the attachments of the pronator quadratus. Note that the *anterior interosseous artery* pierces the interossecus membrane behind the upper border of the muscle, and sends its *communicating branch* downwards over the front of the membrane with the nerve.

Deep Structures on the Front of the Forearm.—These are the anterior interosseous vessels and nerve, the flexor digitorum profundus, the flexor pollicis longus and the pronator quadratus.

The *anterior interosseous artery* has been studied (p. 142).

The **anterior interosseous nerve** is a branch of the median nerve, and arises as the median nerve emerges from between the two heads of the pronator teres. It descends over the front of the interosseous membrane at first between the flexor profundus and the flexor longus pollicis, and then behind the pronator quadratus, and runs onwards to the front of the wrist joint. It gives *muscular* branches to those three muscles, and *articular* branches to the inferior radio-ulnar joint, the wrist joint, and the joints of the hand.

The **flexor digitorum profundus** is a long, thick muscle that lies deeply in the front of the forearm; it lies also, more superficially, on the medial border and the back of the forearm, for it is on the medial side of the ulna as well as on the front of it. Examine the *back* of your forearm, and identify the posterior border of the ulna. The fleshy mass at the medial side of the groove that marks that border is the flexor profundus covered with the aponeurosis of the flexor carpi ulnaris. Place the fingers of your left hand on that mass on the back of the right forearm; close the right fist, and feel the muscle hardening as it contracts to flex the fingers.

The chief origin of the muscle is from the upper three-fourths of the medial and anterior surfaces of the ulna. The fleshy belly becomes a thick tendinous mass which divides into four tendons—one for each finger—but only the tendon for the forefinger becomes separate and distinct in the forearm.

The tendons pass through the carpal tunnel into the palm; and each is inserted into the terminal phalanx of a finger.

The flexor digitorum profundus is supplied by the *anterior interosseous branch of the median* and by the *ulnar nerve.* It is a flexor of all the joints of the fingers, and of the wrist.

The **flexor pollicis longus** lies deeply in the forearm, taking origin chiefly from the upper two-thirds of the front of the radius. A rounded tendon issues from the fleshy belly, proceeds through the carpal tunnel into the palm, and runs laterally to the thumb to be inserted into its terminal phalanx.

It is supplied by the *anterior interosseous nerve.* It is a flexor of all the joints of the thumb and a flexor of the wrist.

The **pronator quadratus** lies deeply in the distal fourth of the forearm, taking origin from the front of the ulna, and passing across to be inserted into the radius. It is supplied by the *anterior interosseous nerve.*

Wrist and Palm

In this dissection the following structures are studied :—

1. Palmaris brevis muscle and the palmar cutaneous nerves.
2. Palmar aponeurosis.
3. Superficial palmar arch and its branches.
4. Median and ulnar nerves and their branches.
5. Flexor retinaculum, flexor tendons and their sheaths.
6. Lumbrical muscles.
7. Short muscles of the thumb and of the little finger.
8. Deep palmar arch and its branches.
9. Princeps pollicis artery and radialis indicis artery.

Before proceeding with the dissection of the palm, the student will revise :—(1) the surface anatomy of the region (p. 70); (2) the superficial veins and nerves (pp. 74, 82); and (3) the deep fascia (p. 87). After the revision is completed, the attachments and relations of the palmaris brevis muscle must be noted.

Palmaris Brevis.—This is a thin, subcutaneous muscle that lies across the uppermost inch of the hypothenar eminence, concealing the termination of the ulnar artery and nerve. It arises from the flexor retinaculum and the palmar aponeurosis, and is inserted into the skin of the medial border of the hand. It is supplied by the superficial terminal branch of the ulnar nerve. Acting simultaneously with the flexors of the digits, it enables the hand to take a firmer grip, for it raises up a

cushion of skin and fascia on the hypothenar eminence, and prevents it from being flattened under pressure.

Dissection.—Reflect the palmaris brevis towards its origin, and secure its nerve of supply. Remove the deep fascia from the hypothenar muscles. Clean the *ulnar artery* till it disappears behind the palmar aponeurosis ; and secure its *deep branch*, which sinks backwards between the hypothenar muscles. Find the terminal branches of the *ulnar nerve*. Trace the superficial terminal branch to its subdivision into the palmar digital branches (which have been dissected already). Trace the deep terminal branch into the cleft between the two superficial muscles of the hypothenar eminence ; secure its branches to those two muscles and to the deeper muscle of the eminence. Then, separate and clean those three muscles, avoiding injury to their nerves.

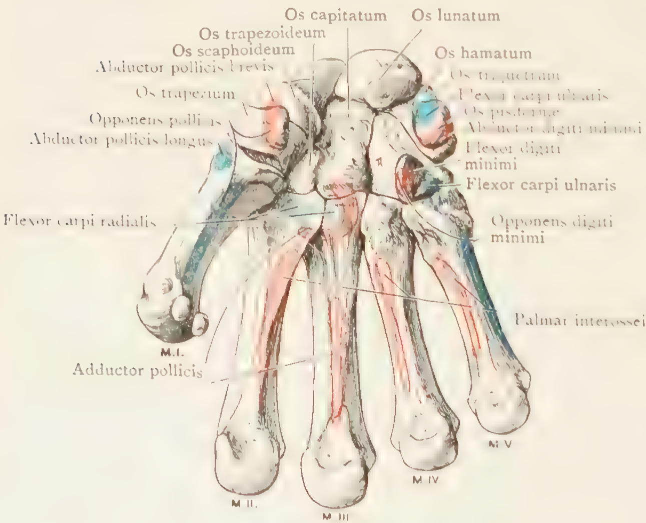


FIG. 61.—Palmar Surface of the Bones of the Carpus and Metacarpus with Muscular Attachments mapped out.

Short Muscles of the Little Finger. The three short muscles of the little finger make up the hypothenar eminence or ball of little finger. They are the abductor, the flexor, and the opponens. The abductor lies along the medial side of the flexor, and the opponens is deep to both. They are all supplied by the deep branch of the *ulnar nerve*.

The **abductor digiti minimi** is the largest of the three.

It arises from the pisiform bone, and is inserted into the medial side of the base of the first phalanx of the little finger.

The **flexor digiti minimi** is a muscle of very variable size. It springs from the hook of the os hamatum and the flexor retinaculum, and is inserted with the abductor. It is partly fused with the abductor, and is not uncommonly incorporated, to a greater or less extent, in the opponens.

The **opponens digiti minimi** lies on a deeper plane. It arises from the hook of the os hamatum and the flexor retinaculum, and is inserted into the whole length of the medial part of the front of the fifth metacarpal bone.

Dissection.—Clear away the slip of the palmar aponeurosis which goes to the thumb, taking care to avoid injury to the digital nerves of the thumb. Next, separate the apex of the palmar aponeurosis from the tendon of the palmaris longus and from the flexor retinaculum, and define the distal margin of the retinaculum. Then, reflect the aponeurosis towards the roots of the fingers. Do not fail to note that, from its medial and lateral margins, septa pass backwards into the palm. Divide these septa, and continue the reflexion until the deep surfaces of the processes which pass to the fingers are fully exposed. Note that, at the roots of the fingers, each process divides into two slips. Clean these two slips, and note their connexions with the fibrous flexor sheath and with more deeply placed ligaments.

Palmar Aponeurosis. This dense, strong fibrous sheet underlies the superficial fascia of the middle part of the palm, and protects the tendons and the chief vessels and nerves which are proceeding to the fingers. It is composed of strong longitudinal fibres mixed with transverse fibres which bind them together.

It is triangular in outline. Its *apex* is situated at the distal border of the flexor retinaculum. There, its deeper fibres fuse with the retinaculum, while the superficial fibres are continuous with the tendon of the palmaris longus.

Its *lateral* and *medial margins* are continuous with the deep fascia that covers the thenar and hypothenar muscles; and, from each margin, a septum is sent backwards into the palm to fuse with the fascia on the muscles that lie deeply in the palm. These two septa separate the thenar and hypothenar muscles from the long flexor tendons of the fingers. The *lateral septum* fuses with the fascia on a deep muscle called the adductor pollicis. The *medial septum* fuses with the fascia on the deep muscles called the interossei.

The *base* of the aponeurosis is opposite the distal parts of

the metacarpal bones. It divides into four processes—one for each finger—and an occasional, slender process for the thumb. Each process passes towards the root of a digit and

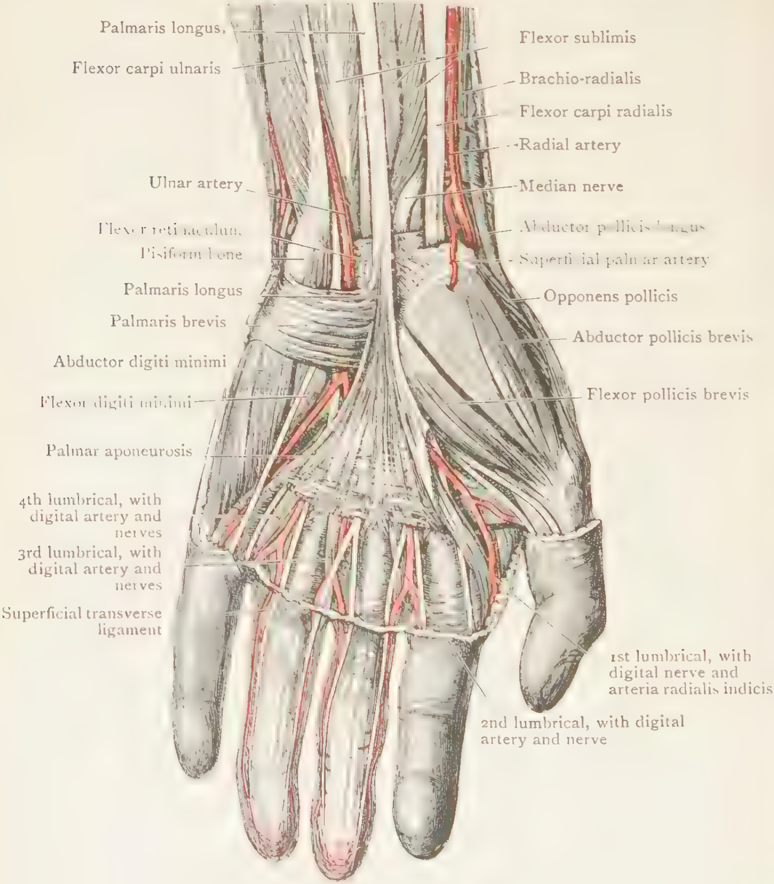


FIG. 62.—Superficial Dissection of the Palm. The deep fascia has been removed from the thenar and hypothenar eminences.

divides into two slips. The slips diverge from each other and curve backwards. Their distal borders are continuous with the fibrous flexor sheath of the digit; their ends fuse with the deep fascia on the back of the digit and with strong

bands, called the deep transverse ligaments of the palm, which lie between the heads of the metacarpal bones and connect the palmar ligaments of adjacent metacarpo-phalangeal joints.

The structures exposed by the reflexion of the palmar aponeurosis are the contents of the intermediate compartment of the palm. They are :—

1. The ulnar artery, continued as the superficial palmar arch.
2. The digital branches of the arch.
3. The terminal branches of the median nerve.
4. The branch of the superficial division of the ulnar nerve to the adjacent sides of the ring and little fingers.
5. The flexor tendons, surrounded by their synovial sheath.
6. The proximal parts of the synovial sheaths of the index, middle, and ring fingers.
7. The lumbrical muscles—four slender slips that arise from the tendons of the flexor profundus.

Fascial Compartments of the Palm.—The two septa which pass from the margins of the palmar aponeurosis into the depths of the palm (Fig. 63) join the fascia on the medial interossei muscles and the front of the adductor of the thumb; and the two heads of the adductor are separated from the interossei of the lateral two interosseous spaces by another layer of fascia. There are, therefore, four main fascial compartments in the palm :—

1. An intermediate compartment, separated into (*a*) a superficial part containing the superficial palmar arch and its branches and branches of the median and ulnar nerves, and (*b*) a deeper part with the flexor tendons and their sheaths.
2. A medial compartment containing the hypothenar muscles.
3. A lateral compartment containing the thenar muscles.
4. An adductor compartment containing the adductor of the thumb.

Fluid which collects in the superficial part of the intermediate compartment can extend upwards, behind the flexor retinaculum, into the forearm, and downwards to the interdigital clefts; in the deep part, it will extend upwards and downwards to the ends of the flexor sheath. In the other compartments it will be localised in the palm.

Dissection.—Clean the *superficial palmar arch* and the four *digital branches* which it gives to the fingers.

Find the lateral and medial terminal branches of the *median nerve*, at the lower border of the flexor retinaculum. Follow the lateral branch first. It soon gives off a stout branch to the muscles of the thenar eminence. Secure that branch at once, and follow it across the medial muscle of the eminence (flexor brevis) to the point where it disappears behind the lateral muscle (abductor

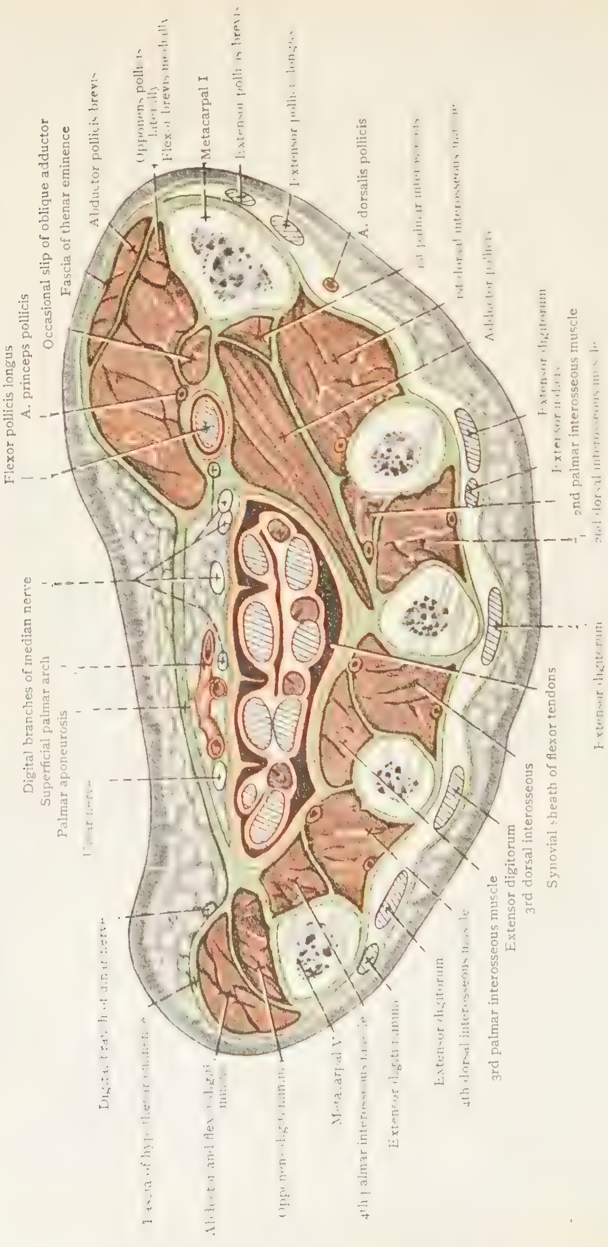


FIG. 63.—Oblique cross section through the Hand, showing the fascial compartments.

brevis). Then, trace the digital nerves to the thumb and forefinger. Trace the one to the forefinger very cautiously, and secure its branch to a slender slip of muscle called the first lumbrical muscle. Now, follow the two digital nerves into which the medial terminal branch divides ; do so with care, for the lateral one gives a branch to the second lumbrical muscle, and the other communicates with the nearest digital branch of the ulnar nerve.

Superficial Palmar Arch. The term superficial palmar arch is applied to an arterial arcade which lies immediately

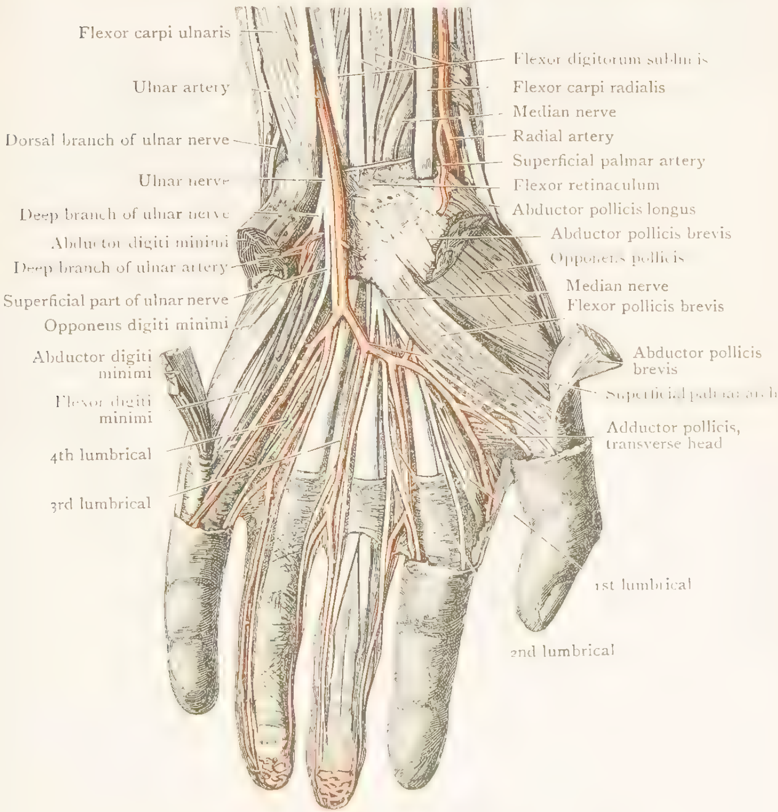


FIG. 64.—The parts in the Palm which are displayed by the removal of the Palmar Aponeurosis. In the specimen from which the drawing was taken the radialis indicis and the princeps pollicis arteries took origin from the superficial palmar arch.

subjacent to the palmar aponeurosis, its most distal point being situated at the level of the distal border of the fully abducted thumb. It is the continuation of the ulnar artery after that artery has given off its deep branch. It begins therefore on the flexor retinaculum immediately below the level of the pisiform bone. It first descends across the medial side of the apex of the hook of the os hamatum; but, a short distance distal to the hook, it turns laterally, pierces the medial septum of the palm, crosses behind the palmar aponeurosis (Fig. 63), and unites, behind its lateral border, with a branch of the radial artery. That branch completes the arch on the lateral side; and it may be either the superficial palmar or the radialis indicis or the princeps pollicis. The arch lies, therefore, in the medial and intermediate fascial compartments of the palm. In the medial compartment, it lies upon the origins of the flexor and opponens digiti minimi from the hook and is covered by the palmaris brevis. In the intermediate compartment it lies upon the digital branches of the median nerve and the flexor tendons, and it is covered by the palmar aponeurosis.

The arch gives off small twigs to the adjacent tendons and fascia, but its chief branches are the *four digital arteries* which spring from its convexity. The first of the four remains undivided. It runs to the medial border of the little finger, along which it passes to the terminal phalanx. The other three branches—second, third, fourth—pass towards the three interdigital clefts, where each divides, at the level of the bases of the first phalanges, into two branches, which supply the sides of the adjacent fingers (Figs. 64, 68, 69).

There are certain practical points to be noted in association with the digital arteries. The first crosses the lateral branch of the superficial terminal division of the ulnar nerve and the short muscles of the little finger. The undivided parts of the second, third, and fourth lie in line with the interdigital clefts; each is situated between two flexor tendons, and is superficial to a digital nerve and a lumbrical muscle. As the branches leave the webs of the fingers, they cross the nerves to lie behind them on the sides of the fingers.

Opposite the terminal phalanx, the two arteries of each finger join to form an arch from which a great number of fine branches are distributed to the pulp of the finger and to the bed upon which the nail rests.

At the cleft of the finger, immediately before it divides, each digital

artery is joined by the corresponding palmar metacarpal artery from the deep palmar arch ; and, as the branches run along the sides of the fingers, they give off numerous twigs to supply the skin, the flexor tendons and the joints of the fingers.

The superficial palmar arch is not uncommonly absent in whole or in part. In such cases, the digital arteries are replaced by the palmar metacarpal branches of the deep arch.

Median Nerve.—This nerve was traced as far as the flexor retinaculum when the front of the forearm was dissected. As it descends into the palm of the hand, it lies behind the flexor retinaculum, in front of the tendons of the flexor digitorum sublimis, or along their lateral margin (Fig. 50), and in close relation with their synovial sheath. Near the distal border of the retinaculum, it is flattened antero-posteriorly, and then splits into a lateral and a medial division.

The *lateral division* is the smaller. It gives off a branch which supplies the abductor brevis, the opponens and the flexor brevis of the thumb ; it then divides into three digital branches. Two of the digital branches go to the sides of the thumb ; the third runs to the radial side of the index finger and, on its way, it gives a twig to the first lumbrical muscle.

The *medial division* divides into two branches. One runs towards the cleft between the index and middle fingers and divides to supply the adjacent sides of those fingers ; before it divides, it gives a branch to the second lumbrical muscle. The other gives a communicating twig to the lateral digital branch of the ulnar nerve, and divides to supply the adjacent sides of the middle and ring digits. It sometimes gives a branch to the third lumbrical muscle.

In the palm, the digital branches of the median nerve are behind the superficial palmar arch and its digital branches ; but, as they approach the fingers, they cross the digital arteries to lie in front of them on the fingers. Note also that the digital nerves divide at a higher level than the arteries do.

Their distribution in the digits is described on p. 85. Turn to that page and read the description again.

Ulnar Nerve.—The ulnar nerve enters the hand by passing on to the front of the flexor retinaculum close to the lateral side of the pisiform bone ; it divides there into two terminal branches—a superficial and a deep.

The *deep branch* passes to the medial side of the hook of the os hamatum, and then dips deeply into the palm, with the

deep branch of the ulnar artery, through the cleft between the abductor and the flexor of the little finger. It supplies the short muscles of the little finger as it passes between them, and afterwards gives branches to numerous other muscles. Its further course and distribution will be seen when the deep part of the palm is dissected (p. 163).

The *superficial branch* descends under cover of the palmaris brevis, to which it gives a twig of supply. Whilst under cover of the palmaris brevis, it divides into two digital branches. The medial of the two branches passes to the medial side of the little finger. The lateral branch pierces the medial palmar septum, and enters the intermediate compartment of the palm. There it is joined by a communicating branch from the first medial digital branch of the median nerve, and then it divides into two branches which supply the adjacent sides of the ring and little fingers (p. 85).

Dissection.—Remove the deep fascia from the muscles of the thenar eminence, but preserve their nerve of supply. Two muscles are then exposed—the abductor and flexor pollicis brevis. The *abductor* is the lateral muscle ; pass the handle of the scalpel behind its lateral border and lift it from the subjacent opponens pollicis. Then, divide the abductor, and turn the two parts upwards and downwards. The *opponens* is then exposed, and must be cleaned.

Next, divide the *short flexor* at its middle and reflect it towards its ends. That will bring into view part of the *adductor pollicis*, emerging from behind the flexor tendons ; and, along the medial border of the opponens pollicis, the tendon of the flexor pollicis longus will be seen ; do not injure its synovial sheath.

At this stage, re-examine the synovial sheaths of the flexor tendons by inflation or with a blunt probe (see p. 133).

Flexor Retinaculum (Transverse carpal ligament).—This band should be thoroughly examined before you divide it to expose the portions of the flexor tendons which lie behind it.

It is a thick, dense, fibrous band which stretches across the concavity of the carpus, and converts it into an osteo-fibrous tunnel for the passage of the flexor tendons into the palm. At the sides, it is attached to the piers of the carpal arch, viz.—on the *lateral side* to the tubercle of the scaphoid bone and the front of the os trapezium, and on the *medial side* to the pisiform bone and the hook of the os hamatum. The attachment to the trapezium is chiefly to the crest at the lateral side of the groove on the front of the bone ; but it sends a process

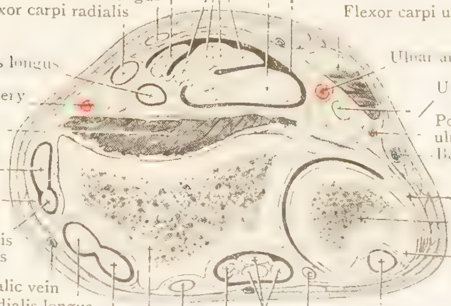


FIG. 65.—Transverse section through Forearm above the Flexor Retinaculum. Showing the relation of the synovial sheaths to the tendons.

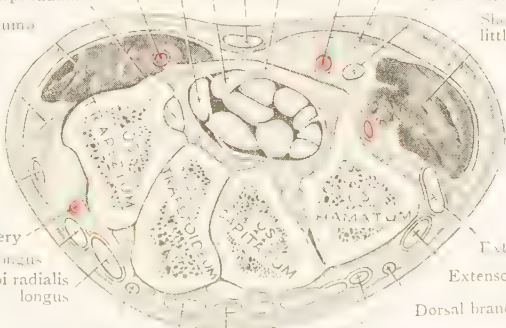


FIG. 66.—Transverse section at the level of the Distal Row of Carpal Bones. Besides the flexor pollicis longus and the median nerve, which are labelled, the tendons of the flexors digitorum sublimis and profundus are seen in the carpal tunnel.

also to the medial margin of the groove. In that way, it converts the groove into a canal which transmits the flexor carpi radialis tendon and is lined with its synovial sheath. Towards the medial end of the retinaculum, a thin sheet of fibres sometimes detaches itself from its anterior surface, and gains independent attachment to the front of the pisiform bone. This *superficial part* crosses in front of the ulnar nerve, and may cross the ulnar vessels also.

The proximal margin of the retinaculum is continuous with the deep fascia of the forearm. The distal border is connected with the palmar aponeurosis, and gives origin to the flexor and opponens of the little finger and the opponens of the thumb.

The front of the retinaculum is concealed by the *thenar* and *hypothenar muscles* that arise from it, and by five structures that descend on to its surface :—(1) the *ulnar nerve*, close to the pisiform bone ; (2) the *ulnar vessels*, on the lateral side of the nerve ; (3) the *palmar cutaneous branch of the ulnar nerve*, lateral to the vessels ; (4) *palmaris longus tendon*, at the middle of the retinaculum ; and (5) the *palmar cutaneous branch of the median nerve*, at the lateral side of the tendon.

The tunnel which the flexor retinaculum forms with the concavity of the carpus is transversely oval in shape, and it opens distally into the intermediate compartment of the palm. It transmits the tendons of the flexor digitorum sublimis, the flexor digitorum profundus, the tendon of the flexor pollicis longus and the median nerve.

Dissection. **Clean the fibrous sheaths of the flexor tendons of the fingers and the thumb.**

Fibrous Flexor Sheaths.—The fibrous flexor sheaths lie subjacent to the skin, the superficial fascia and the palmar digital vessels and nerves. They are the deep fascia of the fronts of the digits, greatly condensed in order to hold the flexor tendons in contact with the palmar surfaces of the phalanges and the joints during flexion of the digits. Each sheath is an elongated plate, curved round the front and sides of the flexor tendons. Its edges are attached to the margins of the phalanges and the margins of the palmar ligaments of the metacarpo-phalangeal and interphalangeal joints. Its distal end is attached to the palmar surface of the distal phalanx just beyond the insertion of the flexor profundus tendon. At its proximal end, it is continuous with the corre-

sponding slip or process of the palmar aponeurosis. It consists chiefly of transverse fibres; and it is very dense opposite the phalanges, but is thinner and weaker opposite the joints in order that it may not interfere with the flexion of the joints.

Each sheath, together with the phalanges and the palmar ligaments of the joints, forms an osteo-fibrous canal which lodges the flexor tendons enclosed in a synovial sheath. In a finger, the tendons are the flexor sublimis and profundus; in the thumb, it is flexor pollicis longus alone.

> ***Dissection.***—Leave the fibrous sheath of the middle finger intact for revision. Open the other sheaths by longitudinal incisions. Evert the two halves of the fibrous sheath, and examine the extent and arrangement of the synovial sheath. Lift up the tendons and separate them. Examine their insertions; note their relations to each other; and examine also the slender bands, called *vincula*, which connect the tendons to the phalanges.

Synovial Sheaths in the Digits.—Each synovial sheath extends to the insertion of the tendon into the base of the terminal phalanx. The sheath of the thumb extends from the interphalangeal joint up into the forearm an inch above the crease at the wrist. The sheath of the little finger is continuous with the large sheath in the palm. The sheaths of the other digits extend almost to the middle of the palm, but are not continuous with the large sheath.

Each sheath has two layers. One layer lines the canal; the other covers the tendons, investing each tendon separately. They are continuous with each other at the ends of the sheath; their contiguous surfaces are smooth and glistening, and are moistened with the film of synovia that fills the capillary interval between them.

The **vincula tendinum** are thin fibrous structures that pass between the bones and the tendons. They carry blood-vessels to the tendons; and they are covered with synovial membrane. They are of two kinds—long and short. The *vincula brevia* are triangular sheets set between the bones and the tendons at their insertion. The *vincula longa* are very slender bands situated nearer the root of the finger (Fig. 67).

Insertions of the Flexor Tendons. The insertions of the two flexor tendons can now be studied. On the palmar surface of the first phalanx, the tendon of the flexor sublimis becomes flattened and folded round the subjacent cylindrical tendon of the flexor profundus. It then splits into two parts,

which pass behind the tendon of the flexor profundus, and allow the profundus tendon to proceed onwards between them. Behind the profundus tendon, the two portions of the tendon of the flexor sublimis fuse together and partially decussate, and then, again, they diverge, to be inserted into the borders of the shaft of the second phalanx. By this arrangement the flattened tendon of the flexor sublimis forms a short tubular passage through which the tendon of the flexor profundus proceeds onwards to the base of the terminal phalanx. In each of the four fingers the same arrangement is found: the tendon of the flexor sublimis is inserted by two slips into the margins of the palmar surface of the second phalanx, whilst

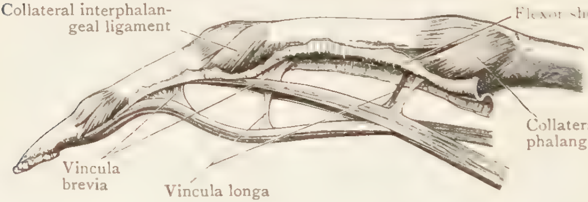


FIG. 67.—Flexor Tendons of the Finger with Vincula tendinum.

the tendon of the flexor profundus is inserted into the palmar surface of the base of the terminal phalanx.

Dissection.—Open the carpal tunnel by making a vertical incision through the middle of the flexor retinaculum. Clean the synovial sheaths from the flexor tendons. Separate the tendons carefully from one another, and clean the slender slips—the *lumbrical muscles*—which spring from the tendons of the flexor digitorum profundus, taking care not to injure their nerves.

Examine the arrangement of the flexor tendons and the origins and insertions of the lumbrical muscles.

Flexor Tendons of the Fingers.—The four tendons of the *flexor sublimis* are arranged in pairs deep to the flexor retinaculum; those for the little and the index fingers lie behind those for the ring and middle fingers. Of the tendons of the *flexor profundus*, only that for the index finger is distinct and separate; the other three, as a rule, remain united until they emerge from under cover of the retinaculum.

In the intermediate compartment of the palm, the flexor tendons diverge from each other; and two, viz., one from the flexor sublimis, and one from the flexor profundus, go to each

of the four fingers. From the tendons of the flexor profundus the lumbrical muscles take origin ; and those little muscles, and the palmar digital nerves and arteries, will be seen in the intervals between the tendons as they approach the fingers.

In the *fingers*, the two flexor tendons run along the palmar surfaces of the phalanges, and are held in position by the fibrous flexor sheaths, which have already been studied.

Tendon of the Flexor Pollicis Longus.—This tendon occupies the lateral part of the carpal tunnel, and, gaining the palm, it turns laterally, and runs along the lower margin of the thenar eminence towards the thumb.

As it proceeds towards the thumb, along the eminence, it lies first between the fleshy bellies of the flexor pollicis brevis and adductor pollicis, and then between the two little sesamoid bones which lie in the tendons of those two muscles. At the base of the proximal phalanx, it enters the fibrous flexor sheath, and runs to the base of the terminal phalanx, into which it is inserted. Its synovial sheath begins an inch above the crease at the wrist, and extends to the insertion.

Mm. Lumbricales.—The lumbrical muscles are four slender fleshy bellies which arise from the tendons of the flexor digitorum profundus as they traverse the palm. The *first lumbrical* arises from the lateral side of the tendon for the index finger ; the *second lumbrical* springs from the lateral border of the tendon for the middle finger ; whilst the *third* and *fourth lumbricals* take origin from the adjacent sides of the tendons between which they lie (viz., the tendons for the middle, ring, and little fingers). The little muscles end in delicate tendons. Each tendon passes backwards across the lateral surface of a metacarpo-phalangeal joint, is connected with the expansion of the extensor tendon, and is inserted, with the tendon of an interosseous muscle, into the base of a terminal phalanx (p. 172 and Fig. 79).

The lateral two lumbrical muscles are supplied on their superficial surface by twigs from the digital branches of the median nerve for the index finger ; the medial two on their deep surface by the deep branch of the ulnar nerve ; the third lumbrical often receives an additional twig from the most medial digital branch of the median nerve.

Dissection.—Divide the flexor digitorum profundus in the forearm, and turn the distal part towards the fingers. As the tendons and the lumbrical muscles are raised, secure the fine

twigs of supply which pass to the medial two lumbricals. They are easily found if ordinary caution is observed.

Now, clean the *deep palmar arch* and the *deep branch of the ulnar nerve*, and trace the branches of the nerve to the interossei muscles and to the adductor pollicis.

FIG. 68.—Diagram of Nerves and Vessels of Hand in relation to Bones and Skin Markings.

Deep Palmar Arch and Deep Branch of Ulnar Nerve.—Two arteries take part in the formation of the **deep palmar arch**—the radial and the deep branch of the ulnar.

The radial plays the chief part. It enters the palm through

FIG. 69.—Radiograph of a Hand in which the Arteries were injected.

Note (1) That the injection is incomplete.
(2) That the superficial palmar arch is completed by the princeps pollicis artery.
(3) That the radialis indicis artery is a branch of the superficial palmar arch.
(4) The relation of the deep palmar arch to the metacarpal bone.

FIG. 70.—Radiograph of Wrist and Palm of girl aged 17.
(Dr. J. Duncan White.)

the proximal end of the first interosseous space, between the two heads of the first dorsal interosseous muscle. In the present stage of dissection, it is seen appearing through the cleft between the oblique and transverse heads of the adductor pollicis (or through the transverse head), and running medially to join the deep branch of the ulnar artery at the base of the fifth metacarpal bone.

The arterial arcade, so formed, lies across the metacarpal bones, immediately distal to their bases. The deep arch is, therefore, about a finger's breadth nearer the wrist than the superficial arch is. The convexity of the deep arch is directed towards the fingers; and the deep branch of the ulnar nerve lies in its concavity.

Its chief branches are three *palmar metacarpal arteries*, which run towards the clefts between the fingers, and unite with the digital branches of the superficial arch. Sometimes these metacarpal arteries are large and take the place of the corresponding palmar digital arteries.

The **deep branch of the ulnar nerve** springs from the parent trunk on the front of the flexor retinaculum, and at once gives off a branch that divides to supply the three short muscles of the little finger. Accompanied by the deep branch of the ulnar artery, it then sinks into the interval between the abductor and flexor digiti minimi, and turns laterally across the palm, deep to the flexor tendons. Near the lateral border of the palm, it breaks up into terminal twigs which supply the adductor pollicis and the first dorsal interosseous muscle. In its course across the palm, it lies along the proximal border of the deep palmar arch, and sends three fine branches downwards in front of the three interosseous spaces. They supply the interosseous muscles in the spaces, while the medial two give branches also to the medial two lumbrical muscles.

The deep branch of the ulnar nerve may, therefore, be said to supply all the muscles of the palm which lie to the medial side of the tendon of the flexor pollicis longus, whilst the median nerve supplies the three muscles which lie to the lateral side of that tendon. The exceptions to this generalisation are the lateral two lumbrical muscles, which are medial to the tendon but are supplied by the median nerve.

Dissection.—Clean the adductor of the thumb and then examine the short muscles of the thumb.

Short Muscles of the Thumb.—Three of the short muscles of the thumb have already been dissected. All four are now displayed. Their relations and attachments should now be studied. Three of the four—the abductor and flexor brevis and the opponens—lie on the lateral side of the tendon of the flexor pollicis longus and form the ball of the thumb; they are supplied by the median nerve. The fourth muscle—the adductor—is on the medial side of that tendon and is supplied by the deep branch of the ulnar nerve.

The *abductor brevis* forms the upper or lateral part of the ball of the thumb. The *flexor brevis* is immediately below or medial to the abductor. The *opponens* is deep to both of them and is exposed when they are pulled apart, or are reflected. The *adductor* is a fan-shaped muscle that lies deeply in the palm.

The **abductor pollicis brevis** arises from the flexor retinaculum and the crest of the os trapezium. It is inserted into the lateral side of the base of the proximal phalanx of the thumb.

The **flexor pollicis brevis** takes origin from the flexor retinaculum. It is inserted with the abductor. A small sesamoid bone is developed in their combined tendons (Fig. 70).

The **opponens pollicis** springs from the flexor retinaculum and the crest of the os trapezium. Its fibres spread out to be inserted into the lateral half of the palmar surface of the first metacarpal bone.

The **adductor pollicis** (Fig. 61) is imperfectly divided into an upper and a lower part, respectively called its oblique and transverse heads. The *oblique head* arises from the front of the carpus. The *transverse head* arises from the front of the third metacarpal bone. The two heads converge, unite, and are inserted into the medial side of the base of the proximal phalanx of the thumb. A small sesamoid bone is developed in the tendon (Fig. 70).

At this stage of the dissection the short muscles of the little finger should be revised (see p. 148).

Dissection.—To display the branches of the palmar part of the radial artery, cut through the two parts of the adductor pollicis midway between their origins and insertions, and turn the separated portions aside. The *first dorsal interosseous muscle* is now exposed; the radial artery will be found entering the palm between its two heads, and giving off its last two branches—the *princeps pollicis* and the *radialis indicis*. At the same time, look for a slender slip of muscle—the *first palmar interosseous*—that lies along the ulnar side of the first metacarpal bone.

Radial Artery in Palm.—The radial artery enters the palm through the proximal end of the first intermetacarpal space, between the two heads of the first dorsal interosseous muscle. In the palm, it lies at first between that interosseous muscle and the adductor pollicis, where it gives off the *radialis indicis* and *princeps pollicis* arteries; and then it passes through the adductor to become the deep palmar arch.

The **radialis indicis artery** descends, between the transverse head of the adductor pollicis and the first dorsal interosseous muscle, to the lateral border of the index, along which it proceeds as its lateral palmar digital artery.

The **princeps pollicis artery** runs laterally, under cover of the oblique head of the adductor, to the metacarpal bone of the thumb, where it lies behind the long flexor tendon, and divides into two branches. Those two branches run onwards along the sides of the long flexor as the palmar digital arteries of the thumb.

Surgical Anatomy of the Palm and Fingers. When an abscess forms in the intermediate compartment of the palm, early surgical interference is urgently called for. The dense palmar aponeurosis effectually prevents the passage of the pus to the surface of the palm, whilst an easy route upwards into the forearm is offered to it by the carpal tunnel. It is necessary, therefore, that before this can occur the surgeon should make an opening in the palm by means of which the pus can escape.

In making such an incision, it is important to bear in mind the position of the various vessels which occupy the intermediate compartment of the palm. As previously stated, the level of the superficial palmar arch can be indicated by a line drawn transversely across the palm from the distal margin of the outstretched thumb. The deep palmar arch lies half an inch nearer the wrist. The palmar digital arteries, which spring from the superficial palmar arch, run in line with the clefts between the fingers. An incision, therefore, which is made distal to the superficial palmar arch and in a direction corresponding to the central line of one of the fingers, may be considered free from danger to the vessels.

The loose synovial sheath which envelops the flexor tendons as they pass behind the flexor retinaculum has been seen to extend upwards into the distal part of the forearm, and downwards into the palm. When the sheath is attacked by inflammation it is liable to become distended with fluid, and the anatomical arrangement of the parts at once offers an explanation of the appearance which is presented. There is a bulging in the palm, and a bulging in the distal part of the forearm, but no swelling at all opposite the carpus. There, the flexor retinaculum resists the expansion of the synovial sheath.

The fingers are subject to an inflammatory process termed *whitlow*, and, in connection with this, it is essential to remember that the flexor fibrous sheath ends on the base of the distal phalanx in each digit. When the whitlow occurs lower down—in the pulp of the finger—the vitality of the distal part of the terminal phalanx is endangered, but the flexor tendons may be regarded as being fairly safe. When the inflammation occurs at a higher level, and involves the flexor sheath, as it

generally does, sloughing of the tendons is to be apprehended, unless an immediate opening is made. No slight superficial incision will suffice. The knife must be carried deeply through the side of the finger, so as freely to lay open the sheath containing the tendons. Early interference in cases of whitlow of the thumb and little finger is even more urgently required than in the case of the other three digits, because the digital synovial sheaths of the thumb and little finger are, as a rule, connected with the great common sheath of the flexor tendons, and so offer a ready means for the extension of the inflammatory action upwards.

Every amputation of the fingers proximal to the insertion of the tendons of the flexor profundus involves the opening of the flexor sheaths, and that no doubt explains the occasional occurrence of palmar trouble after operations of that kind. The open tubes offer a ready passage by means of which septic material may travel upwards into the palm, and, in the case of the thumb and little finger, into the carpal tunnel and the distal part of the forearm.

Back and Lateral Border of Forearm and Back of Hand

The structures to be dissected in these regions are :—

1. The supinator muscle and the extensor muscles.
2. The posterior interosseous artery.
3. The terminal part of the anterior interosseous artery.
4. The posterior interosseous nerve.

Before the dissection is proceeded with, the surface anatomy should be revised (p. 69, 71), and the cutaneous veins and nerves and the deep fascia, previously displayed, should be re-examined (pp. 74, 84, 88).

Dissection.—The extensor retinaculum (dorsal carpal ligament) (p. 88) must be left *in situ* until the dissection of the back of the forearm and hand is completed. To secure its retention in an uninjured condition, isolate it by cutting carefully through the deep fascia parallel with its upper border. Whilst making the incision, avoid injury to the synovial sheaths of the extensor tendons, which lie immediately subjacent to the deep fascia.

When the front of the forearm was dissected, the lateral flap of deep fascia was reflected only as far as the radial border of the forearm. Now, continue the reflexion until the attachment of the flap to the posterior border of the ulnar is reached. As the reflexion proceeds, divide the intermuscular septa.

Muscles of Back of Forearm.—The muscles in this region are arranged in a superficial and a deep group.

Named from the lateral to the medial border of the forearm, the *superficial muscles* are :—

1. Brachio-radialis.
2. Extensor carpi radialis longus.
3. Extensor carpi radialis brevis.
4. Extensor digitorum.
5. Extensor digiti minimi.
6. Extensor carpi ulnaris
7. Anconeus.

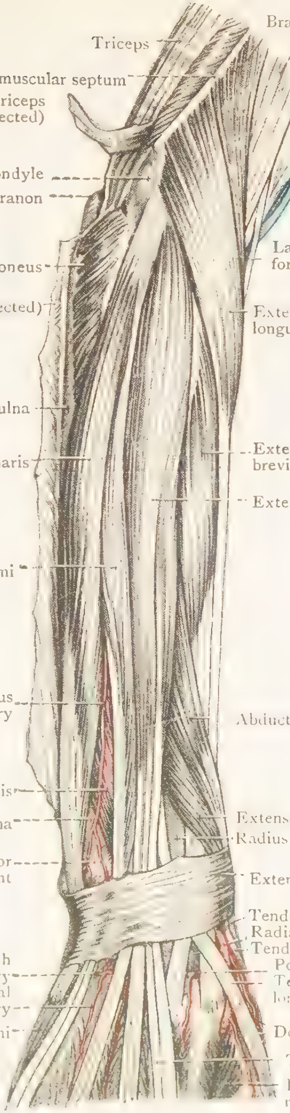


FIG. 71.—Dissection of the Back of the Forearm.

This group therefore comprises one flexor of the elbow, three extensors of the wrist, two extensors of the fingers, and a feeble extensor of the elbow joint, viz., the anconeus.

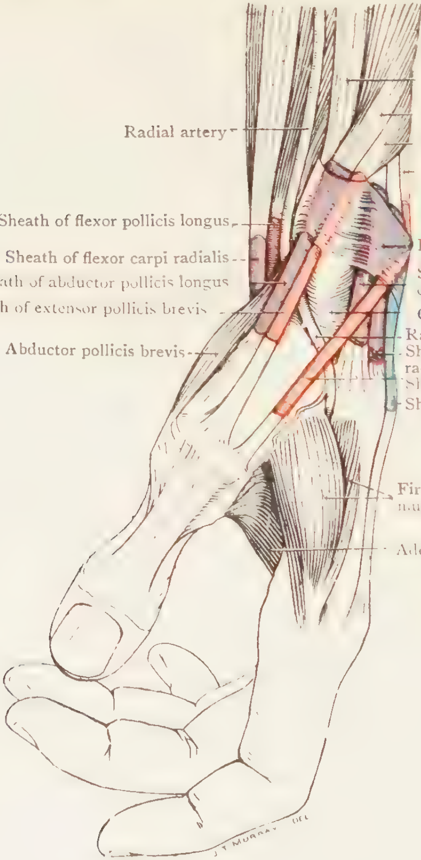


FIG. 72.—Dissection of the Lateral Side of the Left Wrist and Hand showing Synovial Sheaths of Tendons.

In the distal part of the forearm the extensor digitorum is separated from the extensor carpi radialis brevis by a narrow interval in which two muscles that belong to the deep group appear. The two muscles in question turn round the lateral

margin of the forearm, superficial to the radial extensors of the wrist, and end in tendons which go to the thumb. The upper of the two is the *abductor pollicis longus*; the lower is the *extensor pollicis brevis.* They lie in such close contact that in many cases they appear, at first sight, to be blended together by their margins. As their tendons descend to the thumb they lie in the groove on the lateral surface of the lower end of the radius, and are retained in that groove by the most lateral part of the extensor retinaculum (Fig. 72).

A short distance above the retinaculum, on the radial side of the tendons of the extensor digitorum, a third muscle of the deep group also comes into view. It is the *extensor pollicis longus*; its tendon crosses the radial extensors of the wrist at the lower border of the retinaculum.

Dissection.—The deep fascia of the dorsum of the hand is so thin that it will not prevent a successful demonstration of the synovial sheaths of the extensor tendons; attempt to demonstrate them before the superficial extensor muscles are cleaned.

Introduce a blowpipe into each synovial sheath immediately above the retinaculum, and then inflate the sheath. A better demonstration may be made by a thin mixture of coloured starch injected through a large hypodermic syringe. If the sheaths have been injured, and it is not possible to distend them, then open each and examine its extent with the aid of a blunt probe.

Synovial Sheaths of Extensor Tendons.—Eight synovial sheaths surround the tendons which pass through the six compartments under cover of the extensor retinaculum. Two lie along the distal part of the radial border of the forearm (abductor pollicis longus and extensor pollicis brevis); the other six lie on the back of the distal end of the forearm. The order in which the eight sheaths lie, from radial to ulnar side, is :—

1. Abductor pollicis longus.
2. Extensor pollicis brevis.
3. Extensor carpi radialis longus.
4. Extensor carpi radialis brevis.
5. Extensor pollicis longus.
6. Extensor digitorum and extensor indicis, together.
7. Extensor digiti minimi.
8. Extensor carpi ulnaris.

The upper ends of the sheaths lie deep to the extensor retinaculum or slightly above it. The sheaths of the abductor pollicis longus and the radial and ulnar extensors of the carpus extend to the insertions of those muscles. The sheaths of the extensors of the fingers and thumb usually end about the mid-length of the hand (Figs. 72, 73). Occasionally, the abductor pollicis longus and the extensor pollicis brevis have

a common sheath; and sometimes a single sheath encloses the radial extensors of the wrist (see Fig. 65).

Dissection.—The brachio-radialis has been dissected already. Clean the other superficial muscles and isolate them from one another. Their proximal parts are united by fascial septa. Split the septa with the knife, up to the bony origins of the muscles.

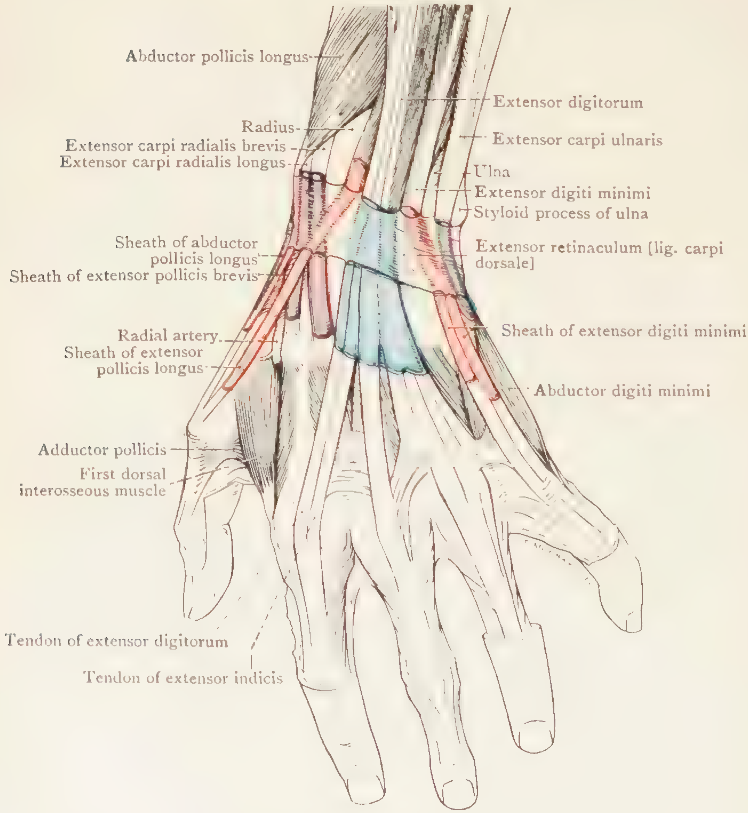


FIG. 73.—Dissection of the Back of the Forearm, Wrist, and Hand, showing Synovial Sheaths of Tendons.

Brachio-radialis.—This muscle lies more on the front of the forearm than on the back. It takes origin, in the upper arm, from the upper two-thirds of the lateral supracondylar

ridge. Near the middle of the forearm a flat tendon emerges from its fleshy belly, and proceeds downwards to gain insertion into the lateral surface of the distal end of the radius, under cover of the tendons of the abductor pollicis longus and extensor pollicis brevis. The nerve of supply is a branch of the *radial nerve* which enters the muscle above the elbow. It can help to initiate supination of the prone forearm and pronation of the supine forearm, but its main action is flexion of the elbow; flex your own forearm against resistance in the semi-prone position, and note how the muscle stands out.

Extensor carpi radialis longus.—This muscle is placed behind the brachio-radialis. It arises from the distal third of the lateral supracondylar ridge. From the fleshy portion of the muscle a long tendon proceeds, which passes under cover of the extensor retinaculum, and is inserted into the base of the second metacarpal bone. The muscle is supplied by a branch of the *radial nerve* which enters it above the elbow. The muscle helps to extend and abduct the hand at the wrist joint, and is a slight flexor of the elbow (Figs. 71, 72, 73).

Dissection.—Remove the deep fascia of the back of the hand. Clear away the synovial sheaths of the tendons, and clean the tendons as far as their insertions; but do not injure (1) the extensor retinaculum, (2) the blood-vessels which lie deep to the tendons and in the intervals between them, (3) the slips which connect the tendons to one another.

Note that the extensor tendon expands on the back of the first phalanx of a finger, but is not inserted into that phalanx. Lift up the *expansion*, clean its edges, and find the tendons of the *lumbrical* and *interosseous muscles*, which are inserted into those edges.

Note, further, that, near the end of the first phalanx, the expanded tendon splits into three slips. On at least one finger, clean those slips, and trace them to their insertions. The middle one is very short, for it is inserted into the base of the middle phalanx; the other two run on, join together edge to edge, and are inserted into the terminal phalanx.

Extensor Tendons of the Fingers. The extensor digitorum gives a tendon to each finger; but the tendon for the little finger seldom separates from the ring finger tendon till it has reached almost to the root of the finger. To a variable extent, the tendons are connected by oblique bands. The most constant connects the ring and middle finger tendons. Because of that connexion and because the tendon for the little finger separates low down, the ring finger has less independent movement than the others

Each tendon spreads out to form the *extensor expansion*, which covers the whole of the back of the proximal phalanx. There it receives part of the insertion of a lumbrical muscle and of either one or two interosseous muscles. The tendon of the index is joined by the extensor indicis also; and the tendon of the little finger by the extensor digiti minimi. On the back of the proximal phalanx, each expansion divides into three slips. The middle slip passes across the joint and carries the

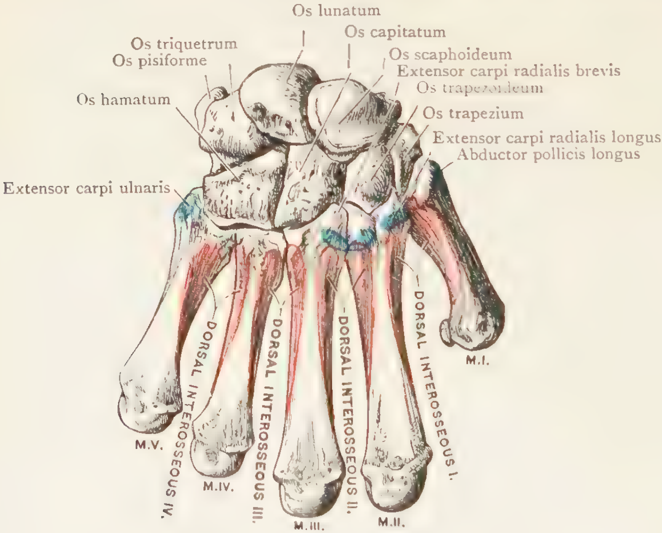


FIG. 74.—Dorsal aspect of the Bones of the Carpus and Metacarpus, with Muscular Attachments mapped out.

main insertion of the extensor into the base of the middle phalanx. The two collateral slips, formed chiefly by the tendons of interossei and lumbricals, converge over the second phalanx, and unite to be inserted into the base of the terminal phalanx (Fig. 79).

The dissector should now note the movements he can make with his own fingers: (1) He can flex all three joints of the fingers the metacarpo-phalangeal, and the proximal and distal interphalangeal joints as in "making a fist." (2) He can extend all three joints. (3) He can flex the interphalangeal joints with the fingers extended at the metacarpo-

phalangeal joints. (4) He can also flex the metacarpo-phalangeal joints and extend the interphalangeal joints. The last combination of movements is called "putting the fingers in the writing position." It is due mainly to the actions of the interossei and lumbricals, which pass from the front to the back across the metacarpo-phalangeal joints, and so are enabled to flex those joints: whilst by virtue of their attachments to the extensor expansions and to the bases of the terminal phalanges they can extend the interphalangeal joints.

Superficial Muscles. The brachio radialis and the extensor carpi radialis longus, which have independent origins, have been described already; four of the remaining muscles have a **common origin** by means of a tendon attached to the lower part of the front of the *lateral epicondyle*, and also from the fascia that covers them and the fascial septa between them. These four muscles are the extensor carpi radialis brevis, the extensor digitorum, the extensor digiti minimi and the extensor carpi ulnaris.

The **extensor carpi radialis brevis** is closely associated with the extensor longus. It arises by the common extensor origin. The tendon of the muscle accompanies that of the long radial extensor under cover of the extensor retinaculum, and is inserted into the base of the third metacarpal bone. This muscle is supplied by a twig from the *posterior interosseous nerve* which is given off before that nerve pierces the supinator muscle. It is an extensor and abductor of the wrist and a slight extensor of the elbow.

The **extensor digitorum** has the common extensor origin from the lateral epicondyle and the fascia. Its fleshy belly, in the distal part of the forearm, ends in a tendon which passes under cover of the extensor retinaculum, and subdivides into tendons for the fingers. On the dorsum of the hand, they diverge and proceed onwards to the fingers; and each is inserted into the middle and distal phalanges in the manner described on p. 172. The muscle is supplied by the *posterior interosseous nerve*. It is an extensor of the fingers, of the wrist, and of the elbow.

The **extensor digiti minimi** has a slender, fleshy belly which at first sight appears to be a part of the preceding muscle, but its tendon passes through a special compartment in the extensor retinaculum. It arises in common with the extensor digitorum. Its tendon of insertion splits into two

parts. The lateral of the two joins the tendon from the extensor digitorum, which, in turn, joins the expansion on the first phalanx, which is formed mainly by the medial part. The muscle is supplied by the *posterior interosseous nerve.* It is an extensor of all the joints of the little finger ; and it aids in extension of the wrist and elbow.

The **extensor carpi ulnaris** arises, by means of the common extensor origin, from the lateral epicondyle and the fascia, including the strong fascia that binds it to the posterior border of the ulna. The tendon does not become free from the fleshy fibres until it is near the wrist. It occupies the groove on the back of the distal end of the ulna, and, passing under cover of the extensor retinaculum, is inserted into the base of the fifth metacarpal bone. The muscle is supplied by the *posterior interosseous nerve.* It is an extensor of the wrist and elbow ; and it aids the flexor carpi ulnaris in adducting the hand.

The **anconeus** lies at the lateral part of the back of the elbow. It is a small, short muscle, of triangular outline, which arises, by a tendon, from the lateral epicondyle. It spreads out to be inserted into the lateral border of the olecranon (Fig. 80) and the upper third of the back of the shaft of the ulna. The nerve of supply is a long slender branch which is given off from the *radial nerve*, behind the middle third of the humerus, and it descends through the medial head of the triceps to reach the muscle. In addition, the distal part of the anconeus sometimes receives a branch from the posterior interosseous nerve. It is an extensor of the elbow joint.

Dissection.—To expose the deep muscles of the back of the forearm and the posterior interosseous vessels and nerve, reflect the extensor digitorum and the extensor digiti minimi by dividing the fleshy portion of each, about its middle, and turning their divided parts upwards and downwards. As the muscles are reflected, secure their nerves. When the reflexion is completed, pull aside the extensor carpi ulnaris ; then the greater parts of the *posterior interosseous vessels* and *nerve* and of the deep muscles will be exposed.

Find the *posterior interosseous nerve* as it emerges from the supinator ; follow it downwards among the muscles, and trace its branches to the muscles. In the lower part of the forearm, it lies very deeply and is joined by the *anterior interosseous artery.* Follow them to the retinaculum ; then, pull aside the extensor digitorum and extensor indicis as they emerge from the retinaculum ; find the nerve and artery again, and trace them to the back of the wrist.

Return to the *posterior interosseous artery,* as it emerges

between the supinator and the abductor pollicis longus, and follow it downwards.

When the nerve and the vessels have been cleaned, clean the muscles ; note where their tendons pass under the retinaculum ; and trace the tendons to their insertions.

Deep Muscles. From above downwards, these are :

1. Supinator.	3. Extensor pollicis brevis.
2. Abductor pollicis longus.	4. Extensor pollicis longus.

5. Extensor indicis.

The supinator (Fig. 76) will be recognised from the close manner in which it is applied to the upper part of the shaft of the radius ; its attachments will be seen at a later stage of the dissection. The other muscles take origin, from above downwards, in the order in which they have been named (Figs. 71, 72, 73, 75, 76).

The **abductor pollicis longus** arises from the back of the interosseous membrane and both bones of the forearm—from the second quarter of the ulna and the middle third of the radius. The muscle proceeds downwards and laterally, and comes to the surface in the interval between the extensor digitorum and the extensor carpi radialis brevis. Then it crosses the two radial extensors, closely accompanied by the extensor pollicis brevis. The tendon which issues from it, as it becomes superficial, is continued downwards, over the lateral side of the distal end of the radius, and under cover of the extensor retinaculum, and is inserted into the base of the metacarpal bone of the thumb ; usually, it sends a slip also to the fascia of the thenar eminence.

The muscle is supplied by the *posterior interosseous nerve*. In addition to being an abductor of the thumb, it assists in abduction of the hand.

The **extensor pollicis brevis** is placed along the distal border of the preceding muscle. It arises from a small portion of the posterior surface of the radius, and also from the interosseous membrane. Its tendon is closely applied to that of the abductor pollicis longus, and accompanies it deep to the extensor retinaculum. It must be traced, along the back of the metacarpal bone of the thumb, to the base of the proximal phalanx, into which it is inserted.

The muscle is supplied by the *posterior interosseous nerve*. It is an extensor of the carpo-metacarpal joint and of the metacarpo-phalangeal joint of the thumb, and it takes a subsidiary part in abduction of the hand.

FIG. 75.—Dorsal aspect of the Bones of the Forearm, with Attachments of Muscles mapped out.

The **extensor pollicis longus** takes origin from the posterior surface of the middle third of the ulna, and also from the interosseous membrane. It overlaps, to some extent, the preceding muscle, and it ends in a tendon which passes under cover of the extensor retinaculum, where it occupies a deep, narrow groove on the dorsum of the distal end of the radius. On the carpus, it takes an oblique course, and, after crossing the tendons of the two radial extensors and the radial artery, it reaches the thumb, and is inserted into the base of the distal phalanx of the thumb.

It is supplied by the *posterior interosseous nerve*. It is an

extensor of all the joints of the thumb, and it takes part in initiating supination of the forearm.

The **extensor indicis** arises, distal to the preceding muscle, from a limited area on the back of the ulna and the interosseous membrane. Its tendon accompanies the tendons of the extensor digitorum through the most medial groove on the back of the radius, under cover of the extensor retinaculum, and is enclosed in the same synovial sheath. On the dorsum of the hand, it lies along the medial side of the most lateral tendon of the common extensor, and it terminates in the expansion of that tendon on the dorsum of the first phalanx of the index finger.

It is supplied by the *posterior interosseous nerve*. It is an extensor of the index finger, and it may assist in its adduction.

Tendons at the Wrist in the Living Limb. Now that the flexor and extensor tendons have been examined in the dissected limb, proceed to examine them at the wrist and the distal part of the forearm in your own limb. First, identify the distal end of the radius and its styloid process ; alternately supinate and pronate the forearm, and identify the styloid process and the head of the ulna. Proceed then to identify the tendons :—

1. Flexor carpi radialis and palmaris longus, at the middle in front. (The palmaris longus may be absent).
2. Flexor carpi ulnaris, along the medial margin of the front of the distal part of forearm.
3. The tendon of flexor sublimis for the ring finger rises into view, between the flexor carpi ulnaris and the palmaris longus, when the fist is closed and the hand is bent forwards.
4. Abductor pollicis longus and extensor pollicis brevis lie close together in the anterior boundary of the " snuff-box," and form a prominent ridge when the thumb is extended. Extensor pollicis longus, running obliquely towards the thumb, lies in the posterior boundary. Extend the thumb to make those tendons taut ; draw your finger firmly along them, and feel the branches of the radial nerve as they cross the tendons.
5. Extensor carpi radialis longus and brevis are crossed and partly hidden by the extensor pollicis longus, but they rise better into view when the fist is closed, for they then contract to prevent the flexors of the fingers from flexing the wrist also ; the brevis stands out more prominently than the longus.
6. Extensor indicis and extensor digitorum lie at the middle of the back of the wrist ; the diverging tendons of digitorum are seen best when the flexed fingers are extended at the metacarpo-phalangeal joints.
7. Extensor digiti minimi lies close to the radial side of the head of the ulna, but is not visible till it enters the hand.

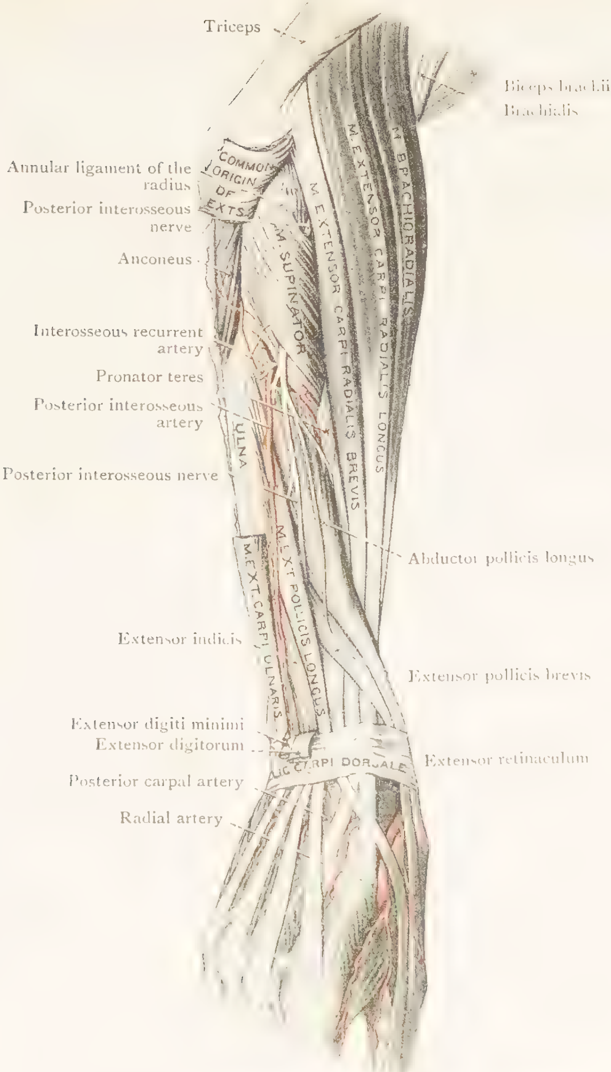
8. Extensor carpi ulnaris, escaping from the groove between the head and the styloid process of the ulna, forms a thick, indistinct ridge at the ulnar margin of the back of the wrist.

When the dissector has examined the tendons in his own forearm, he will return to the dissected limb and study the interosseous vessels and nerves and the anastomosis around the elbow joint, and will complete the examination of the back of the hand.

Posterior Interosseous Artery and Nerve.—The **posterior interosseous artery** arises, in the front part of the forearm, from the common interosseous branch of the ulnar artery. It proceeds backwards at once, between the two bones of the forearm, in the interval between the interosseous membrane and a fibrous slip, called the *oblique cord*, which stretches between radius and ulna a little above the interosseous membrane. It appears in the back of the forearm between the supinator and the abductor pollicis longus, and then runs downwards between the superficial and deep muscles. It reaches the back of the wrist; but its lower part is so slender that it can seldom be traced below the middle of the forearm, unless it is exceptionally well injected. It gives off small branches to the adjacent muscles, and one large branch called the interosseous recurrent artery (Fig. 76).

The *interosseous recurrent artery* takes origin from the parent trunk as it appears between the supinator and the abductor pollicis longus, and runs upwards, under cover of the anconeus muscle, to reach the back of the lateral epicondyle of the humerus.

The **posterior interosseous nerve** springs from the radial nerve a short distance above the lateral part of the front of the elbow joint. It descends across the front of the elbow joint opposite the capitulum of the humerus, under cover of the brachio-radialis muscle, gives branches to the extensor carpi radialis brevis and to the supinator, and then disappears into the supinator. It reaches the back of the forearm by traversing the substance of the supinator obliquely, and at the same time winding round the lateral aspect of the shaft of the radius. It emerges from the supinator a short distance above the lower border of the muscle, and passes downwards, with the posterior interosseous vessels, across the surface of the abductor pollicis longus, under cover of the extensor digitorum.


Triceps
Biceps brachii
Brachialis
Annular ligament of the radius
Posterior interosseous nerve
Anconeus
Interosseous recurrent artery
Pronator teres
Posterior interosseous artery
Posterior interosseous nerve
Abductor pollicis longus
Extensor indicis
Extensor pollicis brevis
Extensor digiti minimi
Extensor digitorum
Extensor retinaculum
Posterior carpal artery
Radial artery
COMMON ORIGIN OF EXTS.
M. SUPINATOR
M. EXTENSOR CARPI RADIALIS BREVIS
M. EXTENSOR CARPI RADIALIS LONGUS
M. BRACHIORADIALIS
ULNA
M. EXT. POLLICIS LONGUS
M. EXT. CARPI ULNARIS
LIG. CARPI DORSALE

About the middle of the forearm, where it reaches the extensor pollicis longus, it leaves the vessels, and descends over the back of the interosseous membrane (with the anterior interosseous vessels), under cover of the extensor pollicis longus and the extensor indicis.

Leaving the interosseous membrane, it descends over the medial part of the back of the radius, still accompanied by the anterior interosseous vessels. On the back of the radius, it lies under cover of the extensor retinaculum and the synovial sheath of the extensor digitorum and extensor indicis. It ends on the back of the wrist joint, under cover of that synovial sheath, in a slight swelling which sends branches to the wrist joint and the intercarpal joints.

The branches of the posterior interosseous nerve are muscular and articular. The *articular* branches supply the elbow joint, the lower radio-ulnar joint, the wrist joint and the intercarpal joints. The *muscular* branches are very numerous, and are distributed :—

By branches that arise in front of the elbow, to

1. Extensor carpi radialis brevis	2. Supinator

By branches that arise in the back of the forearm, to

3. Extensor digitorum	7. Extensor pollicis longus
4. Extensor digiti minimi	8. Extensor pollicis brevis
5 Extensor carpi ulnaris	9. Extensor indicis
6. Abductor pollicis longus	10. Anconeus

It supplies, therefore, all the muscles on the lateral and dorsal aspects of the forearm, with the exception of the brachio-radialis and the extensor carpi radialis longus, which derive their nerve supply directly from the *radial nerve*. The anconeus derives its main nerve of supply from the radial nerve, but not infrequently it obtains a second twig from the posterior interosseous nerve.

Dissection.— Detach the anconeus from its origin and throw it towards its insertion in order to display the interosseous recurrent artery. Trace that artery to the back of the lateral epicondyle ; and then examine the arterial anastomosis around the elbow joint.

Anastomosis around the Elbow Joint.—The anastomoses around the elbow should now be reviewed as a whole. A distinct anastomosis will be found at the front and the back of each epicondyle. Behind the lateral epicondyle, the *interosseous recurrent artery* joins the *posterior branch* of the *profunda brachii artery* ; anterior to the same epicondyle, the *anterior branch* of the *profunda* communicates with the *radial recurrent*. On the medial side, the *anterior* and *posterior ulnar recurrent arteries* ascend respectively in front of and behind the medial epicondyle

of the humerus; the former anastomoses with the *anterior branch* of the *supratrochlear artery*, and the latter with the *posterior* branch of the same artery and with the *ulnar collateral artery*.

In this account of the anastomosis around the elbow joint only the leading inosculations are mentioned. Rich networks of fine vessels are formed over the olecranon and the two epicondyles. One very distinct and fairly constant arch requires special mention. It is formed by a branch which crosses the back of the humerus, immediately above the olecranon fossa, and connects the posterior branch of the profunda with the posterior branch of the supratrochlear artery.

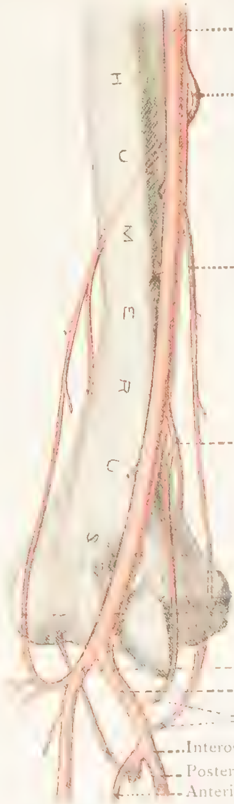


FIG. 77.—Diagram of Anastomosis around the Elbow Joint.

Terminal Part of the Anterior Interosseous Artery.—The anterior interosseous artery is larger than the posterior even after it reaches the back of the forearm. It perforates the interosseous membrane about two inches above the distal end of the radius, and is at once joined by the posterior interosseous nerve. It descends, with the nerve, over the back of the distal end of the radius, and passes to the dorsum of the carpus, where it anastomoses with the end of the posterior interosseous artery and terminates in the *posterior carpal arch*—a small arterial arch on the back of the second row of the carpus, formed by the posterior carpal branches of the radial and ulnar arteries.

On the back of the hand the following structures have still to be examined:—

1. The extensor retinaculum.
2. The radial artery and its branches.
3. The extensor tendons of the fingers.

Extensor Retinaculum (Dorsal carpal ligament).—This fascial band, about an inch wide, lies obliquely across the back of the limb at the junction of the forearm and the wrist. Its superficial surface is crossed, at its medial end, by the basilic vein, and, towards its lateral end, by the cephalic vein and the terminal branches of the radial nerve.

It is longer than the flexor retinaculum; but it is not so strong, for extension at the wrist is not so strong as flexion is, and the extensors are not so liable to spring away from the wrist as the flexors are. It is merely a thickened portion of the deep fascia, and its attachments are so arranged that it does not interfere with the free movement of the radius and hand during pronation and supination.

Superiorly and *inferiorly*, it is continuous with the deep fascia on the back of the forearm and hand. Its *medial end* is attached to the os triquetrum and the styloid process of the ulna. The lateral part must include the tendons that cross the lateral surface of the distal end of the radius; therefore, the *lateral end* is attached, on the front of the limb, to the sharp edge between the lateral and anterior surfaces of the distal end of the radius.

Under the flexor retinaculum, one large compartment or tunnel is formed for the flexor tendons; not so under the extensor retinaculum. Five septa spring from its deep surface to be attached to the head of the ulna and to the ridges on the back of the lower end of the radius, giving additional attachments to the retinaculum and dividing the space under cover of it into six compartments. Each compartment transmits either one or two tendons, and is lined with a synovial sheath which envelops the tendon or tendons, and facilitates their play between the retinaculum and the bone. The sheaths are described on p. 169.

Dissection. Slit the ligament at each compartment. Examine the tendons and synovial sheaths that lie in them.

The *first compartment* is placed on the lateral side of the distal end of the radius. It contains the tendons of the abductor pollicis longus and the extensor pollicis brevis.

The *second compartment* corresponds with the most lateral groove on the back of the radius. It is broad and shallow, and it holds the tendons of the extensors carpi radialis longus and brevis.

The *third compartment* is formed over the narrow, deep, oblique groove on the distal end of the radius. It contains the tendon of the extensor pollicis longus.

The *fourth compartment* is placed over the wide shallow groove which marks the medial part of the back of the distal end of the radius. It is traversed by tendons of the extensor digitorum and extensor indicis and, deep to their sheath, by the terminal parts of the posterior interosseous nerve and anterior interosseous artery.

The *fifth compartment* is situated over the interval be-

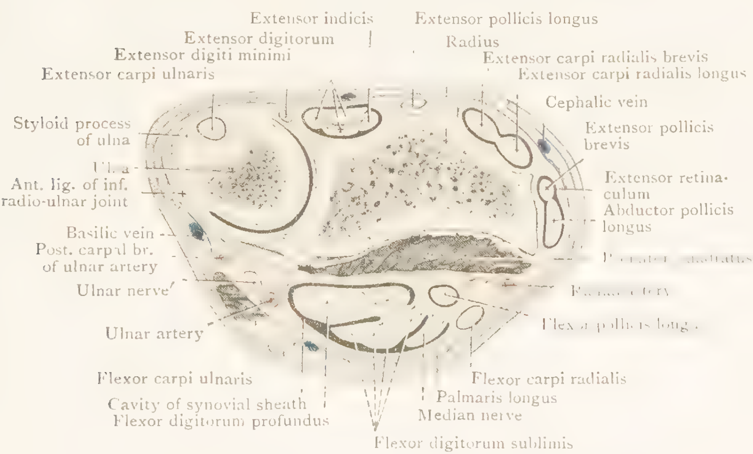


FIG. 78.—Transverse section through Forearm above the Flexor Retinaculum. Showing the relation of the synovial sheaths to the tendons.

tween the distal ends of the radius and ulna. It contains the slender tendon of the extensor digiti minimi.

The *sixth* and *most medial compartment*, which corresponds with the groove on the dorsum of the distal end of the ulna, encloses the tendon of the extensor carpi ulnaris.

Dissection.—Displace the tendons as far as may be necessary, clean the part of the radial artery that lies on the radial side of the wrist, and clean the branches that arise from it there.

Radial Artery.—Only a small portion of the radial artery is seen in this dissection. At the distal end of the radius, the vessel leaves the front of the forearm, turns backwards below the styloid process of the radius, and then descends over the

scaphoid and trapezium to reach the proximal end of the first interosseous space. There, it turns forwards, through the space, between the two heads of the first dorsal interosseous muscle, to enter the palm (p. 165).

As it turns backwards below the radius, it lies on the lateral ligament of the wrist joint, and is crossed by the tendons of the abductor pollicis longus and extensor pollicis brevis. As it crosses the bones (scaphoid and trapezium) it lies on the floor of the "anatomical snuffbox" under cover of the skin and fasciæ, and it can be felt pulsating; the commencement of the cephalic vein overlies it, and may be seen through the skin. Before the artery disappears it is crossed by the extensor pollicis longus and digital branches of the radial nerve.

It is accompanied by two *venæ comitantes* and by some fine filaments from the lateral cutaneous nerve of the forearm which twine round it.

The *branches* which spring from the radial artery in this part of its course are of small size. They are:—

1. Posterior carpal artery. 2. First dorsal metacarpal artery.
3. Dorsal digital arteries—two to the thumb and one to the forefinger.

The *posterior carpal artery* runs medially and joins the posterior carpal branch of the ulnar artery to form the *posterior carpal arch*. That arch lies on the distal row of the carpus under cover of the extensor tendons. It sends two *dorsal metacarpal arteries* towards the clefts between the medial three fingers.

The *first dorsal metacarpal artery* arises from the radial artery either separately or in common with the posterior carpal artery. It runs towards the cleft between the forefinger and middle finger.

Each dorsal metacarpal artery sends two *perforating arteries* forwards through the interosseous space to connect it with the deep palmar arch and with a palmar digital artery; and each one divides into two small *dorsal digital arteries* for the adjacent sides of the fingers.

Two *dorsal digital arteries for the thumb* and one *dorsal digital artery for the radial side of the forefinger* arise independently from the radial artery before it disappears into the palm.

Deepest Structures in Palm and Forearm

The structures that remain to be examined, before the joints are dissected, are the *deep transverse ligaments of the palm*, the *interosseous muscles*, the tendon of the *flexor carpi radialis*, and the *supinator* muscle.

Dissection.—Turn the limb round in order to complete the dissection of the palm. In each space, between the heads of the metacarpal bones, move the lumbrical muscle and the digital nerves and artery to one side, and define and clean the deep transverse ligaments of the palm.

Deep Transverse Ligaments of Palm.—This name is given to the three strong, short, flat bands that lie between the heads of the metacarpal bones of the fingers. At each side, they are attached to the margins of the palmar ligaments of the metacarpo-phalangeal joints. The slips of the palmar aponeurosis gain partial attachment to their palmar surfaces. The lumbrical muscles and digital vessels and nerves lie in front of them. The interosseous muscles lie behind them. Though they are not directly fixed to bones, their connexion with the palmar ligaments of the joints (which are very strong)

FIG. 79.—Dissection of the tendons of the Middle Finger. (From Luschka.)

1. Middle metacarpal bone.
2. Tendon of flexor digitorum sublimis.
3. Tendon of flexor digitorum profundus.
4. Second lumbrical muscle.
5. Second dorsal interosseous muscle.
6. Extensor tendon.

I., II., and III. The three phalanges.

enable them to prevent excessive separation of the metacarpal bones from one another.

> ***Dissection.***—The interosseous muscles have been partly exposed already. To expose them fully, draw the flexor tendons, the lumbricals and the digital nerves and vessels out of the way, remove the transverse head of the abductor pollicis from the third metacarpal bone, and divide the deep transverse ligaments of the palm. Clean the interosseous muscles, define their margins, and follow their tendons backwards to their insertions.

Mm. Interossei.—The interosseous muscles (Fig. 63) occupy the intervals between the metacarpal bones, and to a large extent conceal their palmar aspects. They are arranged in two groups—a palmar and a dorsal—four in each group. The palmar interossei are seen only in the palm. The dorsal interossei are seen best on the back of the hand, but are visible in the palm also.

Except the first palmar, they are all bound to the capsule of a metacarpo-phalangeal joint, have an attachment to the

base of a proximal phalanx and are partially inserted into the extensor expansion on the back of that phalanx.

Since their tendons pass backwards across a metacarpo-phalangeal joint to reach insertion, they flex that joint; and, since they are inserted into the extensor expansion, and the base of the terminal phalanx, they extend the interphalangeal joints. In addition, they either abduct or adduct the fingers from the middle line of the middle finger, according to which side of the metacarpo-phalangeal joint they cross.

The *first palmar interosseous muscle* was exposed when the adductor pollicis was reflected. It is a very slender slip and is not always found. It lies between the adductor pollicis and the first dorsal interosseous muscle, and stretches from the ulnar side of the base of the first metacarpal bone to the ulnar side of the base of the first phalanx of the thumb.

The *second*, *third* and *fourth palmar interossei* act on the forefinger, the ring finger and the little finger. Each arises from the palmar aspect of the metacarpal bone of the finger on which it acts. They flex and extend these fingers in the way described above; and they *adduct* them towards the middle finger. Therefore the second crosses the medial side of the root of the forefinger; the others cross the lateral sides of their respective fingers.

The four *dorsal interossei* lie in the four interosseous spaces and are seen therefore both in the palm and on the back of the hand. Each arises by two heads from the two metacarpal bones between which it lies. They act on the forefinger, the middle finger and the ring finger the middle finger giving insertion to two of them. Like the palmar interossei, they flex and extend, but their chief additional action is abduction. The *first* is inserted on the lateral side of the forefinger, and therefore abducts it from the middle finger. The *fourth* is inserted into the medial side of the ring finger, and abducts it from the middle finger. The *second* and *third* are inserted into opposite sides of the middle finger, and each of these two acts alternately as an abductor and an adductor of that finger.

Each finger is provided, therefore, with an abductor and an adductor :—

The forefinger and the middle and ring fingers have each two interossei that abduct and adduct them. The little

finger has an abductor in the hypothenar eminence, and the fourth palmar interosseous muscle is its adductor.

The dorsal interossei are larger than the palmar. The *first* dorsal interosseous is the largest of them. It is the fleshy mass seen on the back of the hand between the metacarpal bones of the thumb and forefinger. Its action as an abductor of the forefinger, as a flexor of the metacarpo-phalangeal joint and an extensor of the interphalangeal joints can be tested in your own hand.

The interossei are all supplied by the *deep branch of the ulnar nerve*; and, since they act as extensors and flexors of different joints of the fingers, the hand assumes a peculiar shape in ulnar paralysis. Normally, when parts are at rest, there is a balanced neutrality of action between opposing sets of muscles, but each set is ready to take advantage of the other. When the interossei are paralysed, the flexors have lost the help of the interossei in their action on the metacarpo-phalangeal joints; the extensors take advantage of that, and bend the fingers backwards at those joints. But the extensors have lost the help of the interossei in their action on the interphalangeal joints, and the flexors take the opportunity to bend the fingers forward at these joints. The result is the "main en griffe" or claw-hand.

Dissection.—Clear away the thenar muscles from the flexor retinaculum; push the tendon of the flexor pollicis longus aside; and remove the oblique head of the adductor pollicis from its origin. Seize the tendon of the flexor carpi radialis, and put tension on it. Rip through the part of the retinaculum that covers the tendon, and also the extension that the retinaculum sends downwards over it. Pull the tendon out of its groove, and clean it down to its insertion.

Tendon of Flexor Carpi Radialis When this tendon reaches the wrist, it crosses in front of the tubercle of the scaphoid bone, and descends in the groove on the front of the os trapezium. Leaving that groove, it passes to its insertion into the base of the second metacarpal bone. While in the groove, it is covered by the attachment of the retinaculum to the front of the os trapezium, and by the origins of the thenar muscles. The small part between the groove and its insertion is covered by a sheath of fibres prolonged from the retinaculum, and by the origin of the adductor pollicis from that sheath. The tendon of the flexor pollicis longus has a double relation

to it; the flexor pollicis tendon crosses behind it at the wrist joint, and in front of it near its insertion.

Dissection. All the muscles around the elbow joint should be removed. As the brachialis and the triceps are raised, some care is required to avoid injury to the anterior and posterior parts of the capsule. Leave the supinator to the last, because it is only when it is completely isolated that a proper idea of its attachments and mode of action can be obtained. Study its attachments and actions before it is removed.

Supinator.—This muscle envelops the proximal part of the shaft and the neck of the radius, covering it completely, except on its medial side (Figs. 60, 75). It arises chiefly from the floor of the deep depression below the radial notch of the ulna. From their origin, the fibres sweep round the posterior, lateral, and anterior surfaces of the radius, and clothe its shaft as far down as the insertion of the pronator teres. The posterior interosseous nerve supplies the muscle, traverses its substance, and partially separates it into two layers.

JOINTS OF UPPER LIMB

The **shoulder joint** has been dissected already (p. 122).

Elbow Joint

The **elbow joint** (articulatio cubiti) is the articulation of the humerus with the radius and the ulna. The trochlea of the humerus is grasped by the trochlear notch of the ulna; the capitulum of the humerus rests on the concave upper surface of the head of the radius.

It is an example of the *hinge* variety of synovial joints.

Ligaments.—The **capsular ligament** encloses the joint and is thickened at the sides to form *lateral* and *medial ligaments*; the anterior and posterior parts are not specially thickened, but they are called the *anterior* and *posterior ligaments*.

The *anterior ligament* is a thin membrane, but fairly strong. It is attached, superiorly, to the upper margins of the radial and coronoid fossæ and to the medial epicondyle. Inferiorly, it is attached to the anterior margin of the coronoid process of the ulna and to the anterior part of the annular ligament of the radius—a strong band that loops round the head of the radius.

The *posterior ligament* is weak, especially medially.

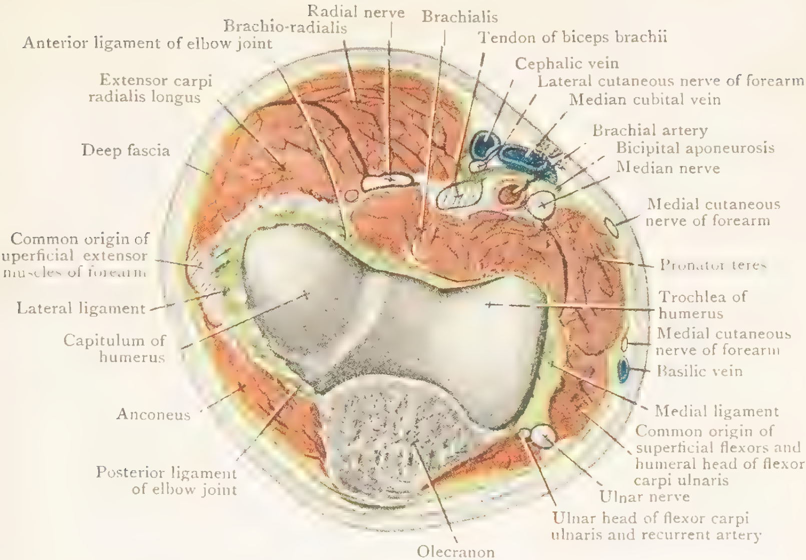


FIG. 80. Transverse section through the Elbow Joint and its surroundings.

FIG. 81.—Sagittal section of the Right Elbow Region.

Superiorly, it is attached to the floor and the medial and lateral margins of the olecranon fossa and to the lateral epicondyle; its attachment to the floor of the olecranon fossa is very loose. Inferiorly, it is attached to the anterior and lateral margins of the olecranon.

The *lateral ligament* (radial collateral) is a strong, short band which is attached to the lower surface of the lateral epicondyle, and spreads out inferiorly to be fixed to the lateral and posterior parts of the annular ligament.

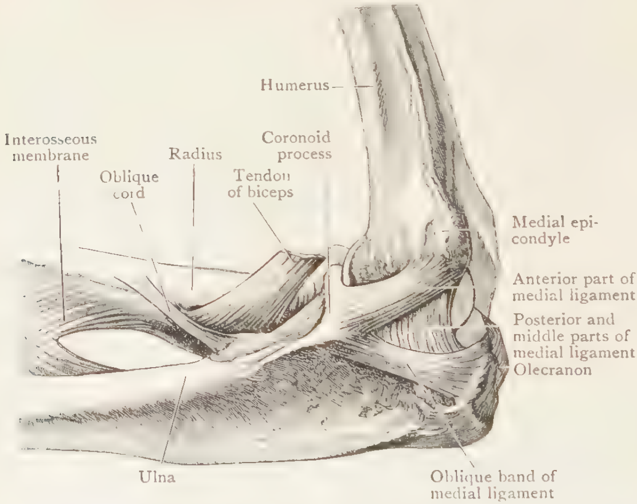


FIG. 82.—Medial aspect of Elbow Joint.

The *medial ligament* (ulnar collateral) radiates from the lower border of the medial epicondyle to the medial margins of the coronoid process and the olecranon and to an oblique band that bridges across the interval between those margins. The anterior and posterior parts of the radiating ligament are thick; the middle part, which is attached to the oblique band, is thin. The ulnar nerve, as it descends from the back of the medial epicondyle into the forearm, lies on the posterior and middle parts of the ligament, and the posterior ulnar recurrent artery ascends close by the nerve.

Dissection. Make transverse incisions through the anterior and posterior parts of the capsule, and examine the synovial membrane.

PLATE IX

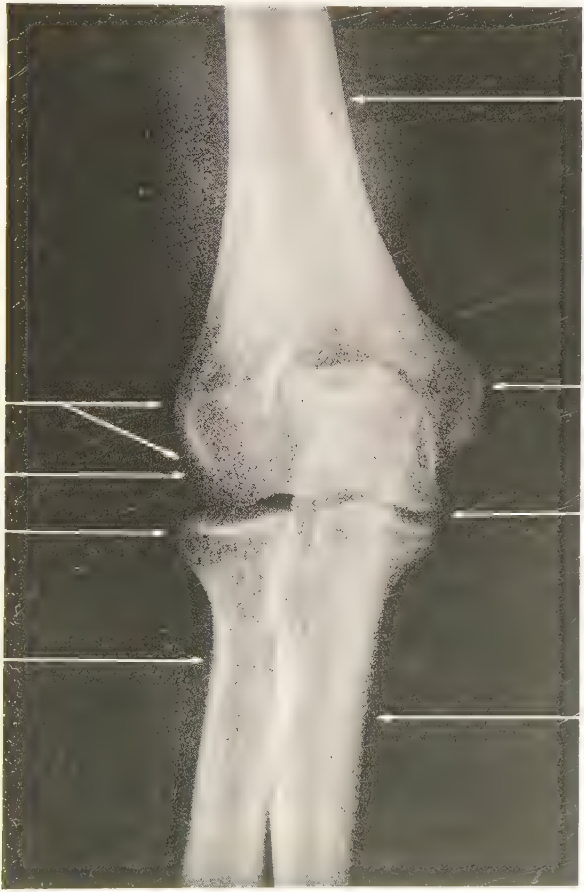


PLATE X

FIG. 84A.—Lateral Radiograph of same Elbow as in Fig. 83 fully extended. Note the tip of the olecranon in the olecranon fossa of the Humerus.

FIG. 84B.—Lateral Radiograph of same Elbow half flexed. Note the relative position of epicondyle and olecranon.

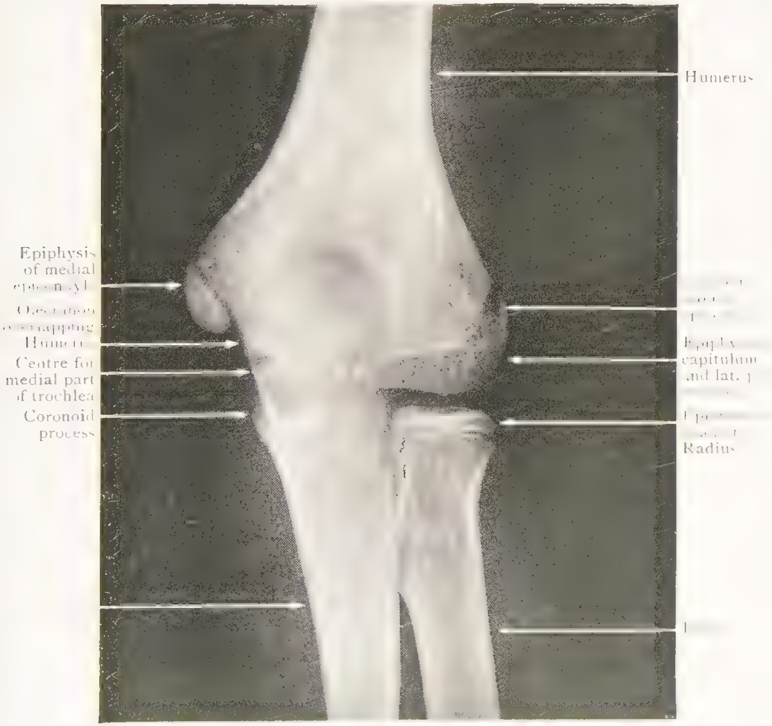


FIG. 85.—Radiograph of Elbow of boy aged 12, showing all epiphyseal centres. The three centres for (1) capitulum and lateral part of trochlea, (2) medial part of trochlea, and (3) lateral epicondyle, unite to form a single epiphysis.

Note the olecranon epiphysis above the part of the olecranon that overlaps the Humerus. Cf. Fig.

PLATE XII

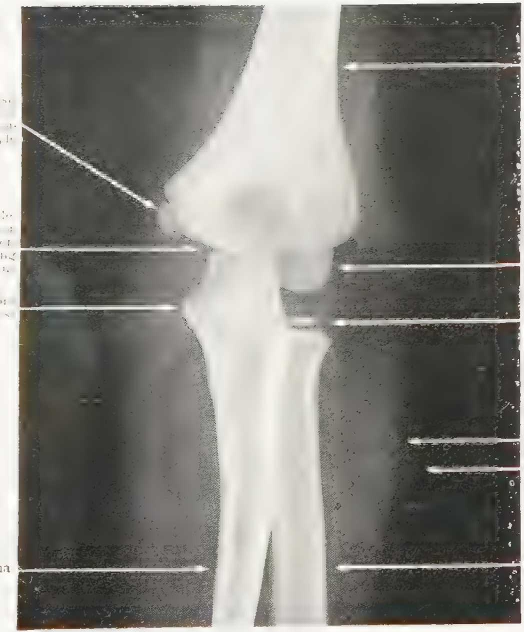


FIG. 86.—Radiograph of Elbow of boy aged 7. (Dr. J. Duncan White.) Note that centre for capitulum forms part of the trochlea, and that the other trochlear centre and the lateral epicondyle centre have not yet appeared. Cf. Fig. 85.

FIG. 87.—Radiograph of Elbow of girl aged 12, showing epiphyses of medial epicondyle of Humerus and head of Radius not yet united.

Synovial Membrane—The synovial membrane lines the deep surface of the capsular ligament. *Superiorly*, it is reflected from the ligament on to the humerus to cover the non-articular part of the bone enclosed within the capsule; and it ends by overlapping the margins of the articular capitulum and trochlea. As it passes over the floor of the

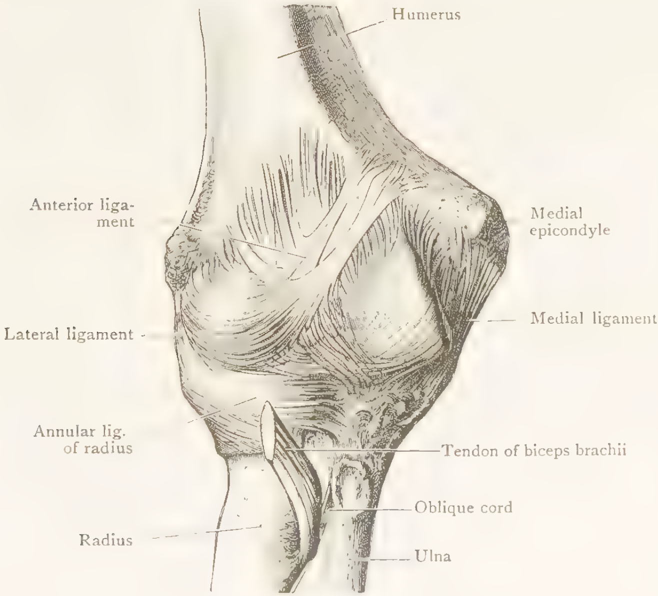


FIG. 88.—Anterior aspect of the Elbow Joint.

olecranon fossa, it is separated from the bone by a little oily fat. Opposite the olecranon fossa and the coronoid and radial fossæ, it is separated from the capsular ligament by pads of fat (Fig. 81) which bulge it into the fossæ when the bony processes are withdrawn.

Inferiorly, at the back and at the front and at the medial side, it passes off the capsular ligament to overlap the articular margins of the coronoid process and the olecranon; but, at the lateral side, it is directly continuous with the synovial membrane of the superior radio-ulnar joint.

The *nerve supply* of the joint is derived from the median, musculo-cutaneous, ulnar, radial and posterior interosseous.

The *structures related* to the surfaces of the joint are shown in Fig. 80, which should be studied very carefully.

Movements at the Elbow Joint.—The movements at the elbow oint must not be confounded with those that take place at the superior radio-ulnar joint. At the elbow joint there are two movements, viz., *flexion* or forward movement of the forearm, and *extension* or backward movement.

The *muscles* which are chiefly concerned in flexing the forearm upon the arm at the elbow joint are the biceps, the brachialis, the muscles attached to the medial epicondyle, and the brachio-radialis. The muscles which extend the forearm are the triceps and anconeus and the muscles which spring from the lateral epicondyle.

Dissection.—It is advisable to study the wrist joint before the radio-ulnar joints are examined.

Cut away the muscles of the thenar and hypothenar eminences. Remove the flexor and extensor retinacula and the flexor and extensor tendons from the wrist—but do not detach the tendons from the digits.

Wrist Joint

The **radio-carpal** or **wrist joint** is the joint between the forearm and the hand. The proximal face of the joint is formed by the lower articular surface of the radius and the articular disc ; and the distal surface consists of the scaphoid, lunate, and triquetral bones, and the two interosseous ligaments which connect them together.

Ligaments.—The opposed surfaces are retained in apposition by a *capsular ligament* in which at least four thickened bands can be recognised, namely :—

1. Anterior radio-carpal lig.	3. Lateral lig. of wrist.
2. Posterior radio-carpal lig.	4. Medial lig. of wrist.

The **capsular ligament** is attached, proximally, to the borders of the distal ends of the radius and the ulna, and to the borders of the articular disc. Distally, it is connected with the bones of the proximal row of the carpus (with the exception of the pisiform) and some of its fibres can be traced to the capitate bone.

The *anterior radio-carpal ligament* springs from the anterior border of the styloid process of the radius and the adjacent part of the anterior border of the distal end of the radius. Distally, it breaks up into flat bands which are attached to the scaphoid, lunate, and capitate bones. In

many cases an *anterior ulnar-carpal* ligament also is found. When present, it extends from the front of the base of the styloid process and the adjacent anterior part of the head of the ulna to the triquetral, pisiform, and capitate bones.

The *posterior radio-carpal ligament* springs from the posterior border of the distal end of the radius, and is attached distally to all the bones of the proximal row of the carpus, except the pisiform. Its fibres are often separable into a number of distinct bands.

The *lateral ligament of the wrist* (radial collateral) passes

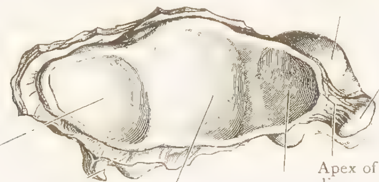


FIG. 89.—Carpal Articular Surfaces of the Radius and of the Articular Disc of the Wrist.

from the tip of the styloid process of the radius to the lateral part of the scaphoid ; and the *medial ligament of the wrist* (ulnar collateral) connects the styloid process of the ulna with the triquetral bone.

> ***Dissection.*** Divide the anterior, medial and lateral ligaments by a transverse incision across the front of the joint. Bend the hand backwards to expose the articular surfaces.

Articular Surfaces.—The *carpal surface* is composed of the proximal articular facets of the scaphoid and lunate bones and a very small articular facet on the extreme lateral part of the proximal surface of the triquetral bone. Two interosseous ligaments stretch across the narrow intervals between the three bones—one on each side of the lunate bone—and complete the carpal surface. The carpal surface thus formed is convex in all directions. Further, it should be observed that the articular surface extends downwards to a greater extent on the back than on the front.

The *proximal surface* or *socket* (Figs. 89, 95) is elongated from side to side, and concave in all directions. The greater part of it is formed by the distal end of the radius, but, on the medial side, the articular disc of the inferior radio-ulnar joint also enters into its construction. The distal articular surface of the radius extends lower down posteriorly and laterally than anteriorly and medially, and it is divided by a low ridge into two facets — a lateral triangular and a medial quadrilateral. The lateral facet, in the ordinary position of the hand, is in contact with the greater extent of

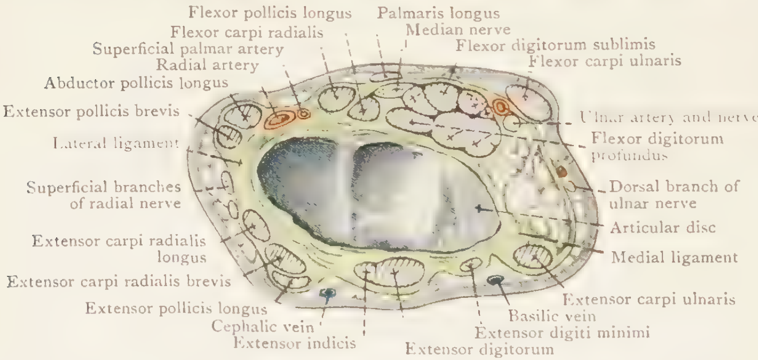


FIG. 90.—Transverse section through the Wrist Joint and its surroundings.

the proximal articular surface of the scaphoid bone. The medial facet, together with the articular disc, forms a much larger surface, triangular in outline, which is opposed to the proximal articular surface of the lunate bone. When the hand is placed in line with the forearm no part of the proximal articular surface is allotted to the triquetral bone: its small articular facet rests against the medial part of the capsule of the joint. When the hand is moved medially (*i.e.* adducted), however, the triquetral bone travels laterally, and its articular surface comes into contact with the distal surface of the articular disc. The lunate bone at the same time crosses the bounding ridge on the distal surface of the radius, and encroaches on the territory of the scaphoid bone, whilst a considerable part of the surface of the scaphoid bone leaves the radius and comes into contact with the lateral part of the capsule.

Synovial Membrane.—The synovial membrane lines the capsular ligament and covers the proximal surfaces of the two interosseous ligaments which complete the carpal surface. Sometimes the articular disc is imperfect, and in those cases the synovial membrane of the radio-carpal joint is continuous with the synovial membrane of the inferior radio-ulnar joint.

The *nerve supply* is derived from the anterior and posterior interosseous nerves and the dorsal branch of the ulnar nerve.

The *structures related* to the joint are shown in Fig. 90. Study them there and on your own wrist.

Movements at the Radio-carpal Joint. The hand can be moved in four directions at the radio-carpal joint. Thus we have:—(*a*) forward movement or *flexion*; (*b*) backward movement or *extension*; (*c*) medial movement or *adduction*; (*d*) lateral movement or *abduction*. In estimating the extent of these movements in the living person, the student is liable to be misled by the increase of range contributed by the inter-carpal joints. Thus, flexion is in reality more limited than extension, although by the combined action of both inter-carpal and radio-carpal joints the hand can be carried much more freely forwards than backwards. Adduction (ulnar flexion) can be produced to a greater extent than abduction (radial flexion). In both cases the extent of movement at the radio-carpal joint proper is very slight, but the range is extended by movements of the carpal bones. The styloid process of the radius interferes with abduction.

The *muscles* which are chiefly concerned in producing the different movements of the hand at this joint are the following:—(*a*) *Flexors*—the flexor carpi radialis, the palmaris longus, and the flexor carpi ulnaris; (*b*) *Extensors*—extensor carpi radialis longus, the extensor carpi radialis brevis, and the extensor carpi ulnaris; (*c*) *Abductors* or *radial flexors*—flexor carpi radialis, extensor carpi radialis longus, abductor pollicis longus, and the extensor pollicis brevis; (*d*) *Adductors* or *ulnar flexors*—extensor carpi ulnaris and flexor carpi ulnaris.

In addition, all the muscles whose tendons cross the front of the joint can, under certain conditions, assist in the production of flexion, and the muscles whose tendons cross the back can assist in extension.

Radio-ulnar Joints

At the two radio-ulnar joints—superior and inferior—the movements of pronation and supination take place. At the *superior joint*, the medial part of the head of the radius fits into the radial notch of the ulna; at the *inferior joint*, the head of the ulna is received into the ulnar notch of the radius.

Ligaments and Synovial Membranes. The ligament of the superior radio-ulnar joint is the *annular ligament*; and at the inferior joint the bones are united by a *capsular ligament* and the *articular disc*.

In addition there are other ligaments which pass between the shafts of the two bones of the forearm, and are, therefore, common to the two articulations, viz., the *oblique cord* and the *interosseous membrane*.

Dissection.—**To expose the oblique cord and the interosseous membrane, remove the muscles from the back and the front of the forearm.**

The **annular ligament of the radius** is a strong, fibrous collar which encircles the head of the radius and retains it in the radial notch of the ulna. It forms four-fifths of a circle, and is attached by its extremities to the anterior

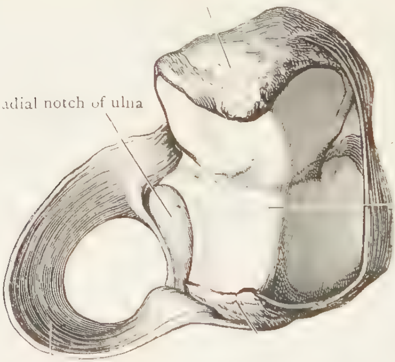


FIG. 91.—Annular Ligament of the Radius.

and posterior margins of the notch. It is slightly narrower below than above, and therefore, under ordinary circumstances, the head of the radius cannot be pulled downwards out of it; and the ligament is braced tightly towards the elbow and also greatly strengthened by the anterior and lateral ligaments of the elbow, which are attached to its upper border. Its lower border is attached, loosely, to the neck of the radius by a thin layer of fibrous tissue which closes the joint inferiorly except at the medial side, where the closure is completed by the quadrate ligament.

The *quadrate ligament* is a small, loose, weak sheet of fibres that connects the neck of the radius to the lower margin of the radial notch of the ulna, and is connected, anteriorly and posteriorly, to the lower edge of the annular ligament.

The **synovial membrane** of the superior radio-ulnar joint is a prolongation downwards of the synovial membrane of the elbow joint ; and, because of the continuity of their cavities, this joint is sometimes described as part of the elbow joint. The synovial membrane lines the deep surface of the annular ligament and the upper surface of the quadrate ligament. It extends downwards to line the thin fibrous layer that connects the annular ligament with the neck of the radius, and is reflected upwards again to overlap the articular cartilage around the head, thus enclosing the intra-capsular part of the neck of the radius in a tubular sheath.

The **capsular ligament of the inferior radio-ulnar joint** consists of lax fibres which can have little influence in retaining the distal extremities of the bones in apposition. It is attached to the anterior and posterior borders of the articular disc, and to the front and back of both bones of the forearm, extending upwards to the lower ends of their interosseous borders to enclose an upward prolongation of the cavity of the joint called the *recessus sacciformis*.

The **articular disc** is the true bond of union at the inferior radio-ulnar joint. It has already been noticed in connexion with the radio-carpal joint, where it extends the radial articular surface in a medial direction ; it separates the distal end of the ulna from the lunate and triquetral bones, and intervenes, therefore, between the cavities of the wrist joint and the inferior radio ulnar joint (Fig. 95). It is a thick, firm, fibro-cartilaginous plate of triangular outline, attached by its base to the distal margin of the ulnar notch of the radius, while its apex is fixed to the depression at the root of the styloid process of the ulna.

The **synovial membrane** lines the capsular ligament, and covers the upper surface of the disc.

Sometimes the articular disc is perforated ; when that is the case, the cavity of the inferior radio-ulnar joint communicates with the cavity of the radio-carpal joint.

The **interosseous membrane** is a fibrous membrane which stretches across the interval between the two bones of the forearm, and is attached to the interosseous border of each. Its upper border is situated about one inch below the tuberosity of the radius. Distally, it blends with the capsule of the inferior radio-ulnar joint. The posterior interosseous

vessels pass backwards, above its upper margin, between the two bones of the forearm ; whilst the anterior interosseous vessels pierce it about two inches from its distal end.

Its fibres run for the most part obliquely downwards and medially from the radius to the ulna, although several strands may be noticed taking an opposite direction. The membrane therefore braces the two bones together in such a manner that forces, passing upwards from the hand through the radius, are transmitted from the radius to the ulna. It also extends the surface of origin for the muscles of the forearm. By its anterior surface, it gives origin to the flexor digitorum profundus and the flexor pollicis longus muscles, whilst from its posterior surface spring fibres of the two extensor muscles of the thumb, the abductor pollicis longus, and the extensor indicis.

The **oblique cord** is a weak band of fibres which springs from the tuberosity of the ulna and extends obliquely, downwards and laterally, to find its attachment to the radius, immediately below the tuberosity of that bone. It crosses the open space between the bones of the forearm above the upper border of the interosseous membrane. The oblique cord is often absent ; and unless the utmost care is taken in removing the adjacent muscles it is liable to be injured.

Dissection. Cut through the annular ligament and the oblique cord, divide the interosseous membrane from above downwards, open the capsule of the inferior radio-ulnar joint, and draw the radius laterally. Examine the connexions of the capsule and the articular disc.

Movements at the Radio-ulnar Joints. The movements of pronation and supination take place at the radio-ulnar joints. When the limb is in the position of complete supination, the thumb is directed laterally, and the two bones of the forearm are parallel. In the movement of pronaion, the radius is thrown across the front of the ulna, so that its distal end comes to lie on the medial side of the ulna. Further, the hand moves with the radius, and when the movement is completed the back of the hand is directed forwards, and the thumb is turned medially.

The dissector should analyse, as far as is possible in the dissected part, the movements at the two radio-ulnar joints. But the range of movement in a limb in which the dissection has proceeded so far is apt to be deceptive. Therefore, the dissector should use himself and his friends as subjects on which to study the movements.

In the *superior radio-ulnar joint*, the movement is simple enough. The head of the radius merely rotates within the annular ligament ; and accuracy of motion is obtained by the head of the radius resting and moving upon the distal end of the humerus. Note that the head of the radius does not fit accurately upon the capitulum in all positions of the elbow joint. In extreme extension and extreme flexion, it is only partially

PLATE XIII

PLATE XIV

FIG. 94A.—Radiograph of Wrist and Hand of girl aged 7. (Dr. J. Duncan White.) Note the relative position of the ossifying carpal bones—the pisiform centre has not yet appeared.

FIG. 94B.—Radiograph Wrist and Hand of man aged 25. (Dr. J. Duncan White.) Compare with Fig. 94A for the identification and relative position of the carpal bones.

in contact with it. Therefore the semi-flexed condition of the elbow joint places the radius in the most favourable position for free and precise movement at the superior radio-ulnar joint (Figs. 83, 84A, 84B).

At the *inferior radio-ulnar joint*, the distal end of the radius revolves around the distal end of the ulna. It carries the hand with it, and describes the arc of a circle whose centre is at the attachment of the articular disc to the distal end of the ulna. As the movement occurs, the articular disc moves with the radius, and travels backwards on the distal end of the ulna in supination, and forwards in pronation.

The muscles chiefly concerned in *supination* of the forearm are—the biceps brachii and the supinator, aided by the long abductor, the long extensor of the thumb and the brachio-radialis. The biceps brachii, from its insertion into the posterior part of the tuberosity of the radius, is placed in a very favourable position for supinating.

The *pronators* are—the pronator teres, the pronator quadratus, and, to a certain extent, the flexor carpi radialis and the brachio-radialis. The pronator teres, from its insertion into the point of maximum lateral curvature of radius, can exercise its pronating action to great advantage. The balance of power is in favour of the supinators, on account of the preponderating influence of the biceps.

Intercarpal Joints

In the carpus there are only two joint cavities. One is the cavity of the pisiform joint. The other is common to the rest of the intercarpal joints, for their cavities communicate freely with one another, and thus form one large, irregular, composite cavity.

At the **pisiform joint** the pisiform bone articulates with the palmar surface of the triquetral bone, to which it is attached by an articular capsule.

The dissector has previously noted that the tendon of the flexor carpi ulnaris is inserted into the pisiform bone. As the capsule would be quite incapable by itself of withstanding the strain to which this muscle subjects the joint, certain strong, accessory bands are provided which anchor the pisiform firmly in place. They are the piso-hamate and the piso-metacarpal ligaments. The *piso-hamate ligament* passes from the pisiform to the hook of the hamate bone; and the *piso-metacarpal ligament* attaches the pisiform to the base of the fifth metacarpal bone.

The other **intercarpal joints** share one joint cavity (Fig. 95). The main part of the cavity of the joint lies between the proximal and distal rows; but it sends prolongations upwards between the three bones of the proximal row, and downwards between the four bones of the distal row;

these downward prolongations communicate with the cavity of the carpo-metacarpal joints.

Palmar intercarpal ligaments pass between the palmar surfaces of the bones of the proximal row; *dorsal ligaments* pass between their dorsal surfaces; and *interosseous ligaments* unite the non-articular parts of their contiguous surfaces. These interosseous ligaments have been seen already, for they complete the distal articular surface of the wrist joint.

The members of the distal row of carpal bones are simil-

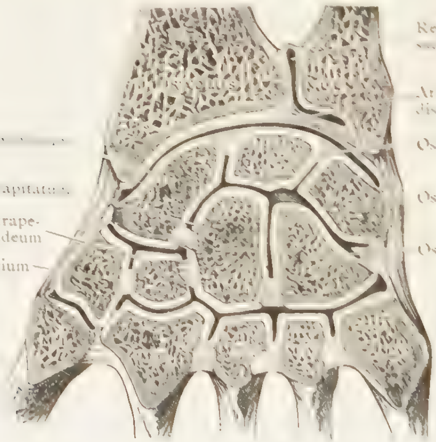


FIG. 95.—Coronal section through Radio-carpal, Intercarpal, and Carpo-metacarpal and Inter-metacarpal Joints to show Joint Cavities and Interosseous Ligaments (diagrammatic).

arly bound together by *palmar*, *dorsal* and *interosseous ligaments*. The interosseous ligament between the capitate and the hamate bones is very strong; that between the capitate bone and the trapezoid bone is weak and may be absent.

At present the interosseous ligaments between the bones of the distal row are hidden from view, but they can be studied when the transverse part of the intercarpal joint is opened.

The **transverse part** of the intercarpal joints lies between the proximal and distal rows of carpal bones. The two rows are bound together by a *capsular ligament* which is attached to the palmar and dorsal surfaces and the medial and lateral

ends of each row. The palmar and dorsal parts of the capsule are strengthened by numerous bands of fibres. The bands on the dorsal surface are irregular in number and strength; but those on the palmar surface are better marked, and, for the most part, they radiate from the capitate to the surrounding bones. One of the bands of this ligament passes from the capitate bone to the styloid process of the radius and blends with the lateral ligament of the wrist joint.

Articular Surfaces (Figs. 70, 94A, 95).—The bones of the proximal row articulate with one another by flat surfaces, and so do the bones of the distal row. In the transverse part of the intercarpal joint, the proximal parts of the capitate bone and the hamate bone form a high convexity which fits into a concavity formed by the distal surfaces of the triquetral and lunate bones and the distal part of the medial surface of the scaphoid bone; and the convex distal surface of the scaphoid bone is received into a concavity formed by the proximal surfaces of the trapezium and trapezoid bones. The two opposed surfaces of the transverse part of the joint are, therefore, concavo-convex from side to side, and adapted one to the other.

The *nerve supply* of the intercarpal joints is derived from the anterior and posterior interosseous nerves, and the dorsal and deep branches of the ulnar nerve.

Movements at the Intercarpal Joints.—The movements at the intercarpal joints supplement those at the radio-carpal joint, and tend greatly to increase the range of movement of the hand. Between the individual bones of each row the movement is of a gliding character, and very limited. At the transverse intercarpal joint, forward and backward movements (flexion and extension) alone are allowed.

By the multiplicity of joints in this part of the limb, strength and elasticity are contributed to the wrist.

> ***Dissection.***—Remove the interosseous muscles from the metacarpal bones, and detach the flexor tendons from the fingers, but leave the extensor tendons in position. Define and clean the ligaments which connect the carpus and metacarpus, and those which unite the bases of the medial four metacarpal bones.

Carpo-metacarpal and Intermetacarpal Joints

The *metacarpal bone* of the *thumb* articulates with the os trapezium by a joint which is quite distinct from the other carpo-metacarpal joints. An articular capsule surrounds the joint, and is sufficiently lax to allow a very considerable range

of movement. On the dorsal and lateral aspects of the joint, it is specially thickened.

The *medial four metacarpal bones* are connected to the carpus by *palmar* and *dorsal ligaments*, and by *one interosseous ligament*; and a *medial ligament* closes in the medial side of the joint of the fifth metacarpal bone.

The *interosseous ligament* springs from the contiguous distal margins of the capitate and hamate bones, and passes to the medial side of the base of the third metacarpal bone

Dissection.—To display the interosseous ligament, divide the bands which connect the bases of the third and fourth metacarpal bones, and sever the dorsal ligaments which bind the medial two metacarpal bones to the carpus. The metacarpal bones thus set free can then be forcibly bent forwards, when the ligament in question will come into view.

The metacarpal bones of the fingers articulate with one another by their bases, and are united by strong ligaments. The metacarpal bone of the thumb stands aloof from its neighbours, and enjoys a much greater freedom of movement.

The ligaments which bind the medial four metacarpal bones to one another are—

1. A series of *palmar* and *dorsal metacarpal ligaments*, which pass transversely between the palmar and dorsal surfaces of their bases.

2. *Three* stout *interosseous ligaments*, which pass between the non-articular parts of the sides of contiguous bases.

3. The *deep transverse ligaments of the palm*, which indirectly connect the heads of the bones (p. 185). These ligaments were cut in the dissection of the interosseous muscles.

The *interosseous ligaments* cannot be seen at present, but can be studied later when the bases of the metacarpal bones are separated from one another.

Synovial Membranes of the Intercarpal, Carpo-metacarpal, and Intermetacarpal Joints. The pisiform joint and the carpo-metacarpal joint of the thumb both possess separate capsules; but the various ligaments of the intercarpal, carpo-metacarpal, and intermetacarpal joints, though they are spoken of individually as separate ligaments, constitute collectively a single capsule, which surrounds a continuous joint cavity. The synovial membrane is prolonged over all the intra-articular parts of the bones that are not covered with

articular cartilage, and it is continued upwards between the three bones of the proximal row of the carpus as far as the interosseous ligaments which bind them together. It covers the distal surfaces of those ligaments and is excluded by them from the radio-carpal joint. It passes also between the four bones of the distal row of the carpus and covers the inner surfaces of the ligaments of the carpo-metacarpal joints and the ligaments of the medial four intermetacarpal joints.

In some cases the interosseous ligament which connects the base of the third metacarpal to the capitate and hamate bones shuts off the articulation of the hamate bone with the medial two metacarpal bones from the other joints.

Dissection.—To display the articular surfaces of the carpo-metacarpal joints, detach the metacarpus from the carpus. To see the interosseous ligaments, separate the bones of the second row of the carpus from one another, and deal similarly with the bases of the metacarpal bones.

Articular Surfaces.—The base of the metacarpal bone of the index will be seen to be hollowed out for the reception of the trapezoid bone. It articulates also with the os trapezium on the lateral side, and with the capitate bone on the medial side. The base of the third metacarpal rests against the capitate bone alone. The base of the fourth metacarpal bone rests upon the hamate bone, but articulates slightly with the capitate bone also. The fifth metacarpal bone articulates with the hamate bone (Figs. 61, 70, 74, 94A and B).

The carpo-metacarpal and intermetacarpal joints are supplied by the anterior and posterior interosseous nerves, and the deep and dorsal branches of the ulnar nerve.

Movements of the Metacarpal Bones.—The opposed saddle-shaped surfaces of the os trapezium and the metacarpal bone of the thumb allow free movement at that joint. Thus, the metacarpal bone of the thumb can be moved—(1) dorso-laterally (extension); (2) forwards and medially (flexion); (3) medially towards the index (adduction); (4) laterally (abduction); (5) medially across the palm towards the little finger (opposition); (6) a combination of the above-mentioned movements, occurring one after the other, constitutes circumduction.

The muscles which operate on the thumb are—(1) The two special extensors (brevis and longus) and the abductor pollicis longus, producing *extension*. (2) The flexor pollicis brevis, the opponens pollicis, and the adductor pollicis, producing *flexion* and *opposition*—two movements which are usually combined. (3) The abductor pollicis longus and the abductor pollicis brevis, producing *abduction*. (4) The adductor pollicis and the first dorsal interosseous muscle, which give rise to *adduction*.

The metacarpal bones of the index and middle fingers possess very little power of independent movement. The metacarpal bone of the ring

finger, and more especially the metacarpal bone of the little finger, are not so tightly bound to the carpus. When the hand is clenched they both move forwards. The metacarpal bone of the little finger is provided with an opponens muscle, which has a feeble power of moving the bone forwards and laterally towards the thumb.

Metacarpo-phalangeal and Interphalangeal Joints

The ligaments of a metacarpo-phalangeal joint are similar to those of an interphalangeal joint.

In each joint there is a **capsular ligament**, thickened in front to form a *palmar ligament*, and thickened at the sides to form *collateral ligaments*. On the dorsum of the joint, the capsular ligament is exceedingly thin and is fused with the overlying extensor tendon.

The **collateral ligaments** are strong oblique bands that pass downwards and forwards from the sides of the head of the proximal bone of the joint to the sides of the base of the distal bone (Fig. 67).

The **palmar ligament** is a strong, thick, fibrous plate. It is attached loosely to the neck of the proximal bone, extends over the palmar surface of the head, and is attached firmly to the base of the distal bone. It forms part of the socket for the head of the proximal bone, whose palmar surface articulates with it when the joint is straight. The margins of each palmar ligament are continuous with the collateral ligaments, and give attachment to the margins of the fibrous flexor sheath; and its palmar surface is covered by the flexor tendon and the synovial sheath.

In a metacarpo-phalangeal joint of a finger, the margins of the palmar ligament give attachment also to the deep transverse ligament of the palm and partial attachment to the processes of the palmar aponeurosis. In the metacarpo-phalangeal joint of the thumb, the palmar ligament is fused with the tendons of the adductor pollicis and flexor pollicis brevis. In the fused ligament and tendons, two little sesamoid bones are developed which articulate with the palmar surface of the head of the first metacarpal bone. Sometimes minute sesamoid bones are found in the palmar ligaments of other metacarpo-phalangeal joints (Figs. 70, 94A).

Some of the metacarpo-phalangeal joints and interphalangeal joints are supplied by the median and radial nerves, and some by the ulnar nerve.

Dissection.—Raise the extensor tendons from the metacarpo-phalangeal joints. If this is done carefully, the dorsal part of the capsule of each joint will be left intact. It is very thin, as the protection afforded by the extensor tendon makes a thick fibrous covering of the synovial membrane unnecessary.

Movements at the Metacarpo-phalangeal Joints. In each metacarpo-phalangeal joint, the concave proximal end of the proximal phalanx articulates with the rounded head of the metacarpal bone. The joints are condyloid; the movements are therefore: (1) flexion, (2) extension, (3) abduction, (4) adduction, (5) circumduction.

During flexion of the fingers, the proximal phalanx and the palmar ligament travel forwards upon the head of the metacarpal bone. The *interosseous* and *lumbrical* muscles are chiefly instrumental in producing this movement, but they are aided by the long and short flexors of the digits.

The proximal phalanges of the fingers, in the movement of extension, can be carried backwards only to a very slight degree beyond the line of the metacarpal bones. The *extensor digitorum* and the *extensores indicis* and *digiti minimi* are the muscles which operate in this case.

Abduction and adduction are movements of the proximal phalanx away from and towards a line prolonged distally through the middle finger, and are seen when the fingers are spread out and drawn together again. The *abductor digiti quinti* and the *dorsal interosseous muscles* act as abductors of the fingers, whilst the *palmar interosseous muscles* operate as adductors of the little, ring, and index fingers. In the case of the middle digit, the *second* and *third dorsal interosseous muscles* act alternately as abductors and as adductors. In connection with the movements of abduction and adduction, it should be noticed that in the extended position of the fingers they are very free; but if flexion is induced, the power of separating the fingers becomes more and more restricted, until it becomes lost when the hand is closed. An examination of the collateral ligaments will afford the explanation of this fact. Their metacarpal attachment is nearer to the distal surface of the head than to the palmar surface. Consequently, while they are comparatively lax in the extended position of the fingers, the further flexion advances the tighter they become, and in this way they interfere with the lateral movements of the proximal phalanges.

Practically, no abduction or adduction is possible at the metacarpo-phalangeal joint of the thumb. These movements take place at its carpo-metacarpal joint.

Movements at the Interphalangeal Joints. The interphalangeal joints are hinge joints; therefore the only movements possible are flexion and extension. Flexion of the middle phalanges of the fingers is brought about by the flexor sublimis, and of the distal phalanges by the flexor profundus. Extension of the phalanges at the interphalangeal joints is produced not only by the extensors of the digits but also by the interosseous and lumbrical muscles acting through the extensor expansions, into which they are inserted; it is probable that extension of the middle and distal phalanges is brought about chiefly by the interossei and the lumbricals. The interossei and lumbricals, therefore, flex the proximal phalanges at the metacarpo-phalangeal joints and extend the middle and distal phalanges at the interphalangeal joints.

In the case of the thumb, the flexor pollicis longus and the extensor pollicis longus operate at the interphalangeal joint.

LOWER LIMB

If the first part allotted to the student is the Lower Limb, he will read the general introductory paragraphs on pp. 1-16 before he begins to study the limb.

Introduction.—The parts of the lower limb are the *hip* and *buttock*, the *thigh*, the *leg*, and the *foot* and *toes*.

The hip and buttock make up what is called the **gluteal region**, which overlies the side and the back of the pelvis, extending from the waist and the small of the back down to the hollow on the side of the hip and to the fold or groove that limits the buttock below. The hip and the buttock are not sharply distinguished from each other either in anatomical descriptions or in ordinary English usage; but the **hip** (coxa) may be taken as the upper part of the region and the part presented in a side view, while the **buttock** (natis) is the rounded bulging behind and below. The groove that limits the buttock inferiorly is called the **fold of the buttock.** The cleft between the buttocks is called the **natal cleft**; its lower part—*i.e.* the part beyond the end of the backbone—is included in the perineum (Fig. 113, p. 251).

The skeleton of the hip and buttock is one bone called the **hip bone** (os coxæ); but it consists of three parts welded together and named the ilium, the ischium and the pubis (Fig. 96). The **ilium** is the large, upper part, and is felt in the lower margin of the waist. The **ischium** is the lower and hinder part. It lies in the substance of the buttock, and the body rests on it in the sitting posture. The **pubis** is the anterior part, and is the bone felt at the lower part of the front of the abdomen.

The hip bone forms part of the skeleton of the trunk also. The right and left hip bones, together with the sacrum and the coccyx (*i.e.* the lowest two pieces of the backbone), make up the skeleton of the pelvis; and the hip bone is sometimes called the *pelvic girdle*. At the front, the two hip bones articulate with each other to form a joint called the **pubic symphysis** (*Symphysis* = union). At the back, they articulate with

PLATE XV

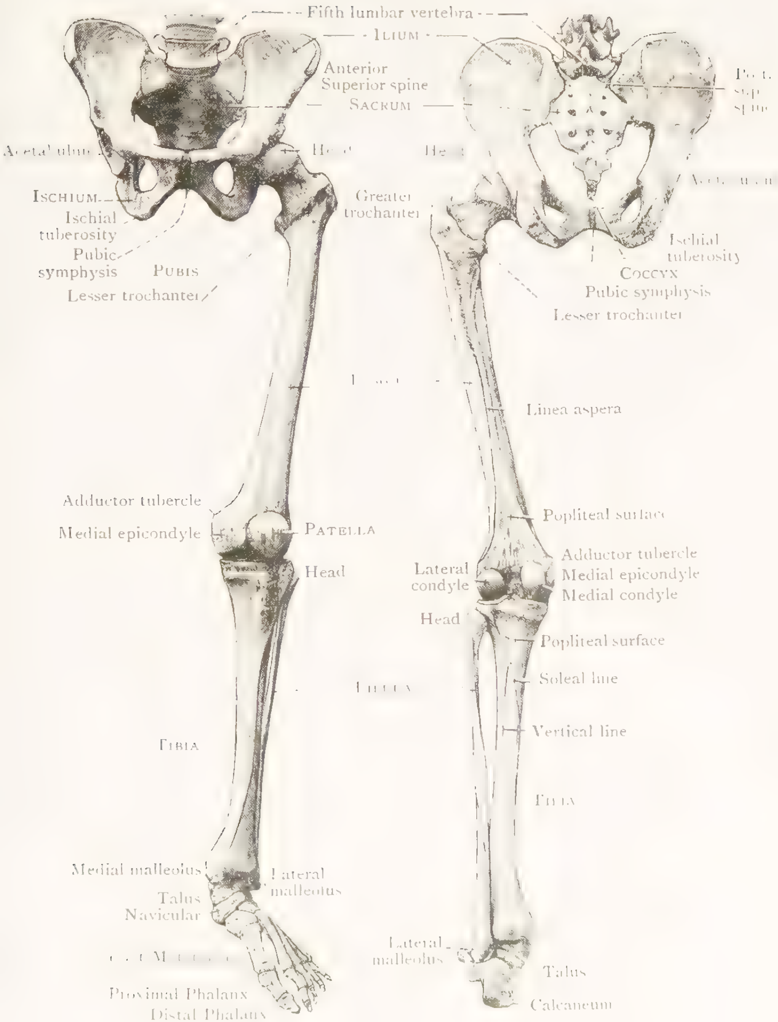


Fig. 96.—Bones of Left Lower Limb.

Anterior view. Posterior view.

PLATE XVI

FIG. 97A.—Radiograph of Foot of boy aged 7. (Dr. J. Duncan White.) Cf. Fig. 94A, noting that the Tarsus is more advanced in ossification than the Carpus, but that the Phalanges of the toes are less

FIG. 97B.—Radiograph of Foot of man aged 43. Compare with Fig. 97A for the identification and relative position of the tarsal bones.

the sides of the sacrum to form a pair of **sacro-iliac joints.** The ligaments that unite the hip bone to the sacrum are very strong, and include two strong bands, called the *sacro tuberous* and *sacro-spinous ligaments*; these two ligaments belong to the dissectors of the Abdomen, but they are met with in the dissection of the gluteal region.

The **thigh** (femur) extends from the hip to the knee (genu). Its bone is called the **femur.** At its upper end, the femur articulates with the hip bone to form the **hip joint.** At the **knee joint,** the femur articulates (1) with the tibia (*i.e.* the larger bone of the leg) and (2) with the **patella** or knee pan, which lies in the front of the knee joint.

The thigh joins the gluteal region at the hollow on the side of the hip and at the fold of the buttock. Medially, it joins the perineum, which separates it from the other thigh. In front, it extends higher up than it does behind, and joins the front of the abdomen at the groove of the groin or **inguinal region.** The **ham** (poples) is the lower part of the back of the thigh and the back of the knee. The hollow of the ham is called the *popliteal fossa.*

The **leg** (crus) extends from the knee joint to the ankle joint. Colloquially, the term "leg" usually means the whole free part of the lower limb; but it never does so in anatomical descriptions. The soft, fleshy part at the back of the leg is the **calf** (sura).

The bones of the leg are the **tibia** or shin bone and the **fibula** or splint bone. They lie side by side—the fibula, which is a very slender bone, lying on the lateral side. At their upper and lower ends, they articulate with each other to form **tibio-fibular joints.** Their lower ends articulate also with the talus (*i.e.* the first bone of the foot) to form the **ankle joint.** The prominent parts of their lower ends, at the sides of the ankle, are called the **lateral malleolus** and the **medial malleolus.** Certain muscles attached to the fibula are called *peroneal* muscles from *peronē*, which is the Greek equivalent of the Latin *fibula* (= a pin or skewer).

The **foot** (pes) extends from the point of the heel (calx) to the roots of the toes. Its upper surface is usually called the *dorsum* of the foot; and its lower surface is the *sole* (planta). The foot is divided into the tarsus and the metatarsus (Figs. 96, 97).

The **tarsus** is the posterior half. Its bones are called

tarsal bones, of which there are seven. They are arranged in two rows—a posterior row and an anterior row—with one of the bones set in between the two rows. There are two bones in the first row—set one above the other. The upper bone is the **talus,** which lies below the tibia; the lower bone is the largest bone of the tarsus, and is called the **calcaneum** because it is the skeleton of the heel. There are four bones in the second row. They are placed side by side—the **cuboid bone** most laterally, and then three bones called **cuneiform bones** because they are wedge-shaped (*cuneus* = a wedge). The bone between the rows is called the **navicular bone**; it separates the cuneiform bones from the talus. The tarsal bones articulate with one another forming **intertarsal joints.**

The **metatarsus** has a skeleton of five **metatarsal bones.** They are set side by side behind the toes, and are numbered 1 to 5—beginning with the one behind the big toe. Their posterior ends are called their *bases*; their anterior ends are called their *heads*. The bases articulate with one another forming **intermetatarsal joints,** and with the cuboid and cuneiform bones forming **tarso-metatarsal joints.**

The **toes** or digits are numbered from medial to lateral side; but the first toe is called also the big toe or *hallux*, and the fifth is the little toe (*digitus minimus*). The bones of the toes are called **phalanges.** The big toe has two phalanges—a proximal phalanx and a distal. Each of the other toes has three—proximal, middle and distal. Each proximal phalanx articulates with the head of a metatarsal bone to form a **metatarso-phalangeal joint.** The middle phalanx articulates with the other two to form **interphalangeal joints.** The proximal end of a phalanx is called its *base* and its distal end is its *head*.

Bones that are embedded in the substance of tendons are called **sesamoid bones.** The largest is the *patella*. The others are very small, and some of them are often absent; the two that are always present lie on the plantar surface of the first metatarso-phalangeal joint (Figs. 97, 190).

FRONT OF THIGH

The dissector of the Lower Limb will begin practical work on the fourth day after the subject has been brought into

the dissecting room. The body is placed on the table lying on its back ; the pelvis is supported by two blocks, and the lower limbs are stretched out at full length. It remains in this position for five days, and during that period the dissector has a very extensive dissection to perform. He has to dissect—(1) the front of the thigh, including the *femoral triangle* and its contents, (2) a portion, at least, of the medial side of the thigh, including the *subsartorial canal* and its contents.

With so much work to be completed, within a limited time, he must apportion the five days to the best advantage. During the first day he should dissect the superficial structures of the whole of the front and medial side of the thigh. During the second and third days he should complete the dissection of the *femoral triangle* and the *subsartorial canal.* The other two days should be devoted to the remainder of the dissection and to revising the whole.

Before making the preliminary incisions in the skin, the dissector must study the surface anatomy of the region.

Surface Anatomy.—The **pubic symphysis** (p. 206, Fig. 96) is in the median plane, at the lowest part of the front of the abdomen, between the right and left pubic bones. Below and behind the symphysis, there is a wide archway, called the **pubic arch**, whose sides are formed by the right and left pubis and ischium. Find the lower part of the symphysis, and press your fingers along one side of the arch. It is at the uppermost part of the medial side of the thigh, in the boundary between the thigh and the perineum. Next, find the upper margin of the symphysis, and draw your finger in a lateral direction. The bone felt is the **pubic crest.** The crest is about one inch long, and, therefore, the bony resistance ceases one inch from the symphysis, at the **pubic tubercle**, which is a small, blunt prominence on the lateral end of the crest.

Find the **iliac crest**, which is the bone felt in the lower margin of the waist. Trace it to its anterior end, and note that its anterior part curves slightly in a medial direction, and slopes markedly downwards. Its anterior end is called the **anterior superior iliac spine**, and, in a thin body, can be gripped between finger and thumb. Between this spine and the pubic tubercle, there is a shallow, curved groove that separates the front of the thigh from the front of the abdomen.

Press your finger along the groove, and feel a resisting, elastic band : that is the **inguinal ligament**, which stretches between the spine and the tubercle. Run your finger upwards and backwards from the spine along the outer edge or lip of the iliac crest. Two or three inches above and behind the spine, the outer lip swells out as a low prominence called the **tubercle of the iliac crest** ; it is at the widest part of the pelvis, and is therefore the highest point of the crest seen and felt when the body is examined from the front, though the actual highest point is farther round at the back. A hand's breadth below the tubercle, a part of the femur, called the **greater trochanter**, is near the surface, and forms a wide prominence just in front of the hollow on the side of the hip ; the top of the trochanter is about the same level as the pubic crest.

The **head of the femur**, which articulates with the hip bone, is deeply hidden under muscles ; but it can be felt. Place your finger on a spot, just below the inguinal groove, midway between the anterior iliac spine and the symphysis pubis ; press firmly ; rotate the limb this way and that ; the head of the femur is felt moving, though it is covered by the capsule of the hip joint and a thick muscle called the *psoas major*. In the living limb, the pulsations of the *femoral artery* are felt at the same spot.

The **shaft of the femur** is thickly covered with muscles throughout its length.

At the knee, the **patella** or knee pan is a familiar object. Three finger breadths below it, there is a blunt prominence on the front of the upper end of the tibia called the **tubercle of the tibia**. The **ligamentum patellæ** stretches from the patella to the tubercle. It is a very strong tendon two inches long and one inch wide that can be gripped between finger and thumb, and is felt best when the knee is half bent. Grasp the patella and try to move it. It is movable when the knee is straight, but not when the knee is bent– for then the ligamentum patellæ is put upon the stretch. When the knee is bent, the patella is drawn off the front of the femur on to its lower end ; and the **patellar surface** of the femur can be felt (if you press firmly) through the muscles above the patella (Figs. 174, 175 A and B).

The large masses of bone at the sides of the knee are the **lateral** and **medial condyles** of the femur and of the tibia.

With the knee bent, feel the sides of the femoral condyles; their most prominent points are called the **lateral** and **medial epicondyles** of the femur, and are nearer the back of the knee than the front.

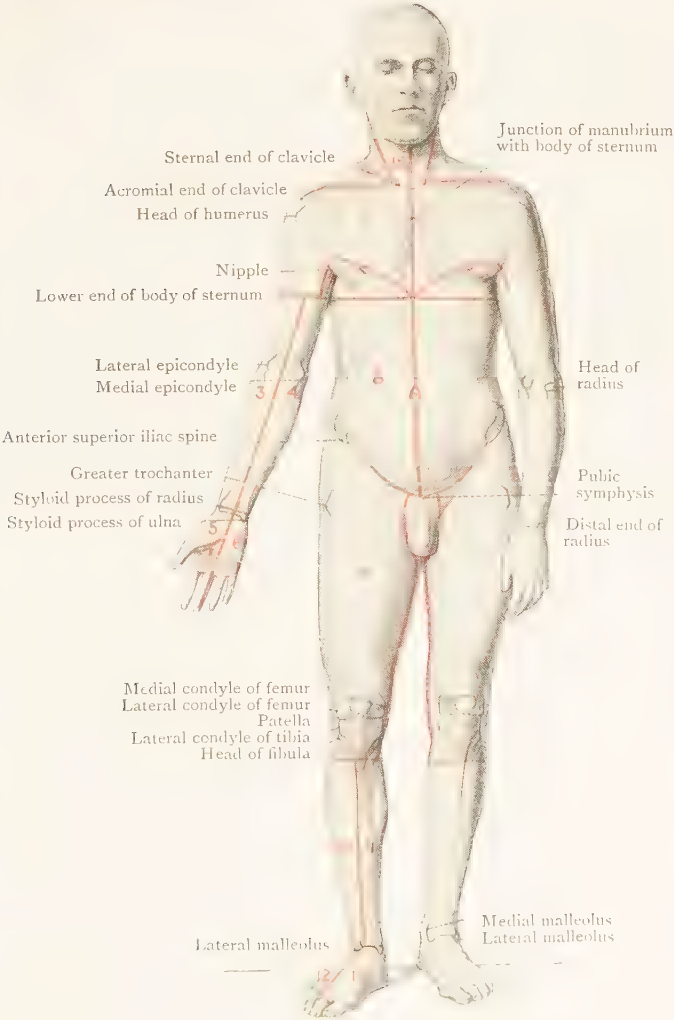


FIG. 98.—Front View of Body showing landmarks and incisions.

Straighten the knee, and look at the posterior part of its medial surface. Note a low, longitudinal fleshy elevation about the width of a finger. It is the lower part of a long muscle called the **sartorius**. Bend the knee, and note that the muscle slips backwards off the medial condyle of the femur into the medial boundary of the popliteal fossa.

The wide, smooth fleshy swelling above the medial condyle is the lower part of a large muscle called the **vastus medialis**. When the knee is bent, that swelling is limited posteriorly by a wide, shallow groove. Press your finger into that groove; a tense band is felt in its floor; that is the tendon of a large muscle called the **adductor magnus**. Draw the finger downwards; it will be caught on a small prominence of bone, called the **adductor tubercle**, which projects from the uppermost part of the medial condyle (Fig. 96).

Superficial Dissection

The structures to be examined in this dissection are:—

1. The superficial fascia.
2. Long saphenous vein and its tributaries.
3. Superficial external pudendal artery.
4. Superficial epigastric artery.
5. Superficial circumflex iliac artery.
6. Lymph glands and vessels.
7. Saphenous opening.
8. Cutaneous nerves.
9. Deep fascia.
10. Patellar bursæ.
11. Spermatic cord in the male; round ligament of the uterus in the female.

General instructions for making incisions and for the removal of skin and superficial fascia are given on p. 14.

Dissection.—Reflexion of the Skin (Fig. 98).—*Incisions.*—(1) From the anterior superior iliac spine along the line of the inguinal ligament to the pubic symphysis; (2) from the medial extremity of the first incision downwards and laterally to the medial side of the thigh, then downwards along the line of junction of the medial side of the thigh and the back of the thigh, and over the medial side of the knee to the level of the tubercle of the tibia; (3) from the lower end of the vertical incision transversely across the front of the leg to its lateral border. The quadrilateral flap of skin, thus mapped out, must be raised carefully from the subjacent superficial fascia and turned laterally, particular care being taken in the region of the knee to avoid injury to the patellar plexus of cutaneous nerves.

Superficial Fascia.—In the region now exposed the fat of the superficial fascia is usually abundant, especially on the

medial side of the thigh. The deeper layer of the superficial fascia is membranous throughout the region; but its membranous character is most manifest in the uppermost part of the region. There, it is to some extent separated from the fatty layer by superficial vessels and a few lymph glands; and the two layers can be completely separated by a little dissection. Both layers of the superficial fascia are continuous with the corresponding layers on the anterior wall of the abdomen. The membranous layer is loosely attached to the deep fascia of the thigh by areolar tissue except near the inguinal ligament, where there is a linear, fairly firm attachment. The line of firm connexion or fusion begins a little lateral to the pubic tubercle and extends nearly horizontally in a lateral direction for about three inches. The medial part of the line may coincide with the medial part of the inguinal ligament or may be a little below it; but, as the lateral part of the ligament is very oblique, the lateral part of the line is farther and farther away from it.

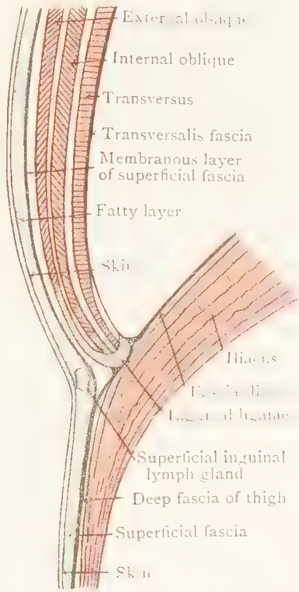


FIG. 99.—Diagram of the Fasciæ and Muscles of the Inguinal and Subinguinal Regions lateral to the Saphenous opening.

This connexion is of some practical importance, and, to demonstrate it, the dissectors of the Lower Limb and the Abdomen must work together.

Dissection.—Make a transverse incision through the entire thickness of the superficial fascia on the front of the abdomen from the anterior superior iliac spine to the middle line of the body. When the lower edge of the divided fascia is raised, its two layers are easily distinguished. Insinuate the fingers between the membranous layer and the pearly-looking aponeurosis of the external oblique muscle of the abdomen. Little resistance will be encountered, for the fascia and the aponeurosis are connected only by some fragile areolar tissue, and the

fingers can be passed downwards as far as the union of the membranous layer with the deep fascia of the thigh. If the fingers are now carried medially along the line of union, it will be found that the line of attachment descends across the front of the pubis, into the perineum, where its connexions were examined by the dissector of the Abdomen when he dissected the perineum.

If urine or other fluid is effused into the anterior part of the perineum, it cannot pass into the medial side of the thigh because of the attachment of the membranous layer of the superficial fascia to the side of the pubic arch and to the front of the pubis, but it can ascend between the membranous layer and the deep fascia to the wall of the abdomen. Having reached the wall of the abdomen, it cannot descend into the front of the thigh because of the connexion between the membranous layer and the deep fascia of the thigh.

The dissector will now proceed to display the structures that lie in the superficial fascia and under cover of it.

Dissection.—Begin with the *long saphenous vein*. It is easily found about the mid-length of the thigh, near the medial border. Cut down upon it there ; clean it, but do not injure its tributaries. Follow the vein downwards to the medial side of the knee, and upwards to its termination in the femoral vein. Some *lymph glands* of fairly large size lie along the sides of the upper part of the saphenous vein. Clean them as you clean the vein, and note the delicate thread-like lymph vessels connected with them. As you approach the upper end of the vein, lift it from its bed, and note that, to reach the femoral vein, it bends backwards over a fairly sharp edge of deep fascia.

The edge of fascia now exposed is the lower margin of the *saphenous opening*, which is an oval gap in the deep fascia, about an inch and a half long and half an inch wide, situated just below the medial part of the inguinal ligament. The thin fascia which closes the opening is called the *cribriform fascia*. The opening will be exposed later.

Dissection. Clean the small blood-vessels. Begin with the veins. They end in the saphenous vein before it passes through the saphenous opening. From that point, trace them towards their origins—the *superficial circumflex iliac* laterally, the *superficial epigastric* upwards, and the *superficial external pudendal* medially. At the same time, clean the arteries which they accompany, and keep the lymph glands that are met with. As the external pudendal artery is traced medially, note that its branches pass superficial to the spermatic cord (Fig. 100).

The *spermatic cord* is a thick, soft bundle—almost as thick as a little finger—that emerges from the abdomen just above

the medial end of the inguinal ligament, and descends into the scrotum. It will be cleaned by the dissector of the Abdomen, but the dissector of the Lower Limb will note that it crosses a corner of his territory. If the subject is a female, the spermatic cord is replaced by a slender, inconspicuous band, called the *round ligament of the uterus*, that emerges through the same point in the abdominal wall and descends into the labium majus.

Dissection. Look for the *ilio-inguinal nerve* (Fig. 102). It is a slender nerve that leaves the abdomen through the lateral part of the aperture through which the spermatic cord or the round ligament passes. Trace the nerve downwards.

Clean the lymph glands that lie along the lower border of the inguinal ligament. They are usually fairly large nodules—about the size of beans.

Next, expose the *saphenous opening*. The lower margin has been found already. Begin there, and define the lateral margin and the upper margin. Clear away the *cribriform fascia*, but do so carefully—disentangling the vessels that pierce it, and avoiding injury to the structures behind it. Try to define the medial margin of the opening. It is a slight, vertical ridge—usually inconspicuous—on a sloping sheet of deep fascia that covers a muscle called the *pectineus*.

The removal of the cribriform fascia exposes the greater part of the anterior wall of the *femoral sheath*—that is the fascial layer that surrounds the uppermost inch and a half of the femoral artery and vein. The sheath is very liable to be injured as the cribriform fascia is removed. If that has happened, the femoral vessels will be partly exposed. Note that the vein is opposite the opening, while the artery is behind its lateral margin.

Dissection.—Look for the superficial nerves. The *ilio-inguinal nerve* has been found already. Seek for the others at the points where they pierce the deep fascia and trace them downwards (Figs. 100, 102).

The *femoral branch of the genito-femoral nerve* pierces the deep fascia a little lateral to the saphenous opening, an inch or less below the inguinal ligament; it is a slender nerve, not easily found. The posterior branch of the *lateral cutaneous nerve of the thigh* pierces the fascia about two inches below the anterior superior iliac spine, and the anterior branch appears about two inches lower down. The *intermediate cutaneous nerve* appears usually as two branches a little distance apart, near the middle line of the thigh about the junction of its upper and middle thirds. The anterior branch of the *medial cutaneous nerve* appears at the junction of the lower and middle thirds, in front of the long saphenous vein; and the posterior branch appears behind the vein near the knee. The *saphenous nerve* appears

behind the vein at the medial side of the knee ; and its *infrapatellar* branch appears in front of the vein above the knee.

Look for a network of slender nerves in front of the patella. It is called the *patellar plexus*, and is formed by branches of the cutaneous nerves. At the same time, see if there is any evidence of a subcutaneous *bursa* in front of the patella.

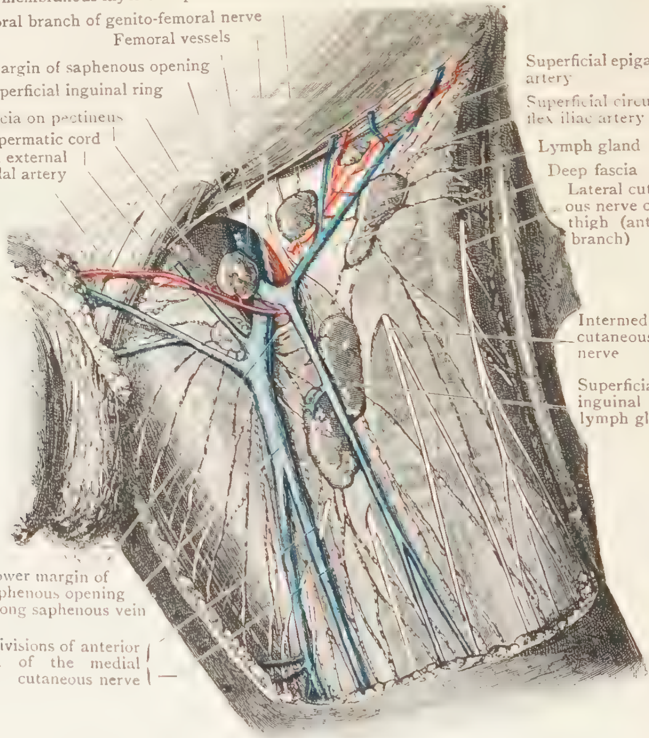


FIG. 100.—Superficial Dissection of the Proximal Part of the Front of the Thigh. The saphenous opening, and the superficial lymph glands and vessels of the groin are displayed. The lymph vessels may be recognised by their beaded appearance.

Superficial Inguinal Vessels.—Three small arteries—the superficial external pudendal, the superficial epigastric, and the superficial circumflex iliac pierce the deep fascia of the thigh below the inguinal ligament, and radiate from each other for the supply of the lymph glands and skin of the

groin (Fig. 100). They all spring from the femoral artery immediately after it enters the thigh.

The *superficial external pudendal artery* passes forwards, through the cribriform fascia, and divides into two or more branches which run medially and upwards across the spermatic cord or the round ligament of the uterus. It supplies the skin of the scrotum and penis or the labium majus.

The *superficial epigastric artery* also pierces the cribriform fascia, and turns upwards to leave the thigh by crossing the inguinal ligament about its middle. It is distributed chiefly to the skin on the front of the abdomen.

The *superficial circumflex iliac artery* pierces the deep fascia a little lateral to the saphenous opening. It is very small, and courses along the inguinal ligament, towards the anterior superior iliac spine.

The *veins* which accompany these arteries converge towards the saphenous opening and join the *long saphenous vein* before it pierces the cribriform fascia.

Lymph Glands and Vessels.—The superficial inguinal lymph glands are arranged in two main groups :—(1) An *upper* group of large glands which are spread out immediately below the line where the membranous layer of superficial fascia is fused with the deep fascia of the thigh ; one or two small outlying members of this group may be found above the inguinal ligament on the course of the superficial epigastric vessels. (2) A *lower* group, which consists of a variable number of large glands placed along both sides of the upper part of the long saphenous vein (Figs. 100, 151).

In a spare subject, or, better still, in a dropsical subject, the general arrangement of the lymph vessels may also be made out. These groups of glands receive the superficial lymph vessels of (1) the lower limb, including the gluteal region, (2) the external genital organs, (3) the perineum, and (4) the lower part of the anterior wall of the abdomen. They receive also some of the lymph vessels from certain organs in the pelvis. Therefore, swollen, painful glands in the groin may signify disease in the superficial parts named above, or they may be a sign of disease in a pelvic organ. Numerous vessels connect the glands with one another. The efferent vessels pass through the cribriform fascia and the deep fascia around the saphenous opening, and end in the deep inguinal glands (which lie alongside the upper part of the femoral vessels) and

in the external iliac glands (which lie in the abdomen around the external iliac artery and are described in Vol. II.

Hiatus Saphenus.—The **saphenous opening** (fossa ovalis) is an oval aperture in the deep fascia of the thigh. It is of importance because through it a femoral hernia makes its way towards the surface; and, therefore, its position and dimensions should be carefully noted. It is about an inch and a half long and half an inch wide. It is situated just below the inguinal ligament, and its centre is about an inch and a half below and lateral to the pubic tubercle. Spread over the opening, there is a thin portion of the deep fascia called the **cribriform fascia** because it is perforated by certain vessels (*Cribrum*—a sieve). These vessels are the long saphenous vein, the superficial epigastric artery, the superficial external pudendal artery, and some of the lymph vessels that connect the superficial and deep inguinal lymph glands.

The femoral vessels, enclosed in a fascial sheath, are immediately behind the opening; the whole width of the vein is exposed in the opening, but the artery is overlapped by the lateral margin.

The upper, lower and lateral margins of the opening form one crescentic, sharp edge of deep fascia called the **falciform margin** of the saphenous opening. The upper margin lies across the femoral sheath and ends medially by being attached to the pubic tubercle and to a triangular expansion of the inguinal ligament called its pectineal portion. The lower margin is better defined than the upper because the long saphenous vein hooks backwards over it to join the femoral vein; it ends medially by joining the pectineal fascia, which forms the medial margin of the opening. The *pectineal fascia* is the portion of the deep fascia that covers the pectineus muscle. The portion of the pectineal fascia exposed here slopes in a lateral direction and backwards, and disappears behind the femoral sheath (Figs. 105, 108); the medial margin of the opening is therefore on a deeper plane than the lateral margin, and is an oblique surface instead of a sharp edge; but occasionally the attachment of the cribriform fascia raises up a ridge on the pectineal fascia which forms a definite medial margin of the opening.

Long Saphenous Vein.—This is the largest superficial vein of the lower limb. In the thigh, it is frequently concealed in the fat, but in the leg it is usually very evident in the living

limb—and hence the name (*Saphēs* = easily seen). It begins on the medial side of the dorsum of the foot, passes upwards in front of the medial malleolus, and ascends through the leg across the medial surface of the distal third of the tibia, and then along the medial margin of the tibia. In the area under dissection, it lies far back on the medial side of the knee, and, continuing its ascent with a lateral and forward inclination, it passes to the saphenous opening, where it pierces the cribriform fascia and the femoral sheath to end in the femoral vein.

During its ascent, it communicates, through the deep fascia, with the deep veins; and it receives numerous tributaries, including the three named superficial veins—epigastric, circumflex iliac and external pudendal—which join it near its termination.

There are several valves in its interior which help to divide the column of blood into sections, and so reduce the pressure on the walls of the distal part of the vein.

Superficial Inguinal Ring.—This is the aperture in the aponeurosis of the external oblique muscle of the abdomen through which the spermatic cord (or the round ligament of the uterus) escapes from the abdominal wall. It has probably been displayed by the dissector of the Abdomen already, and will be studied by him; but the dissector of the Lower Limb will note its position: it is immediately above the pubic tubercle and the medial end of the inguinal ligament.

Cutaneous Nerves.—Six cutaneous nerves are met with in the area of the present dissection—three directly from the lumbar plexus, and three from the femoral nerve, which springs from the lumbar plexus (Figs. 101, 102).

From the lumbar plexus,	Ilio-inguinal nerve. Femoral branch of the genito-femoral nerve. Lateral cutaneous nerve of the thigh.
From the femoral nerve,	Intermediate cutaneous nerve of the thigh. Medial cutaneous nerve of the thigh. Saphenous nerve.

The **ilio-inguinal nerve** escapes through the superficial inguinal ring in company with the spermatic cord or the round ligament of the uterus. Most of its branches go to the scrotum or to the labium majus, according to the sex; but some are distributed to the skin of the adjacent part of the thigh.

The **femoral branch of the genito-femoral nerve** pierces the

deep fascia about an inch below the inguinal ligament, a little lateral to the saphenous opening. It supplies an area of skin, about the size of the palm of the hand, immediately below the inguinal ligament. It communicates with the intermediate cutaneous nerve.

The **lateral cutaneous nerve of the thigh** escapes from the abdomen close to the anterior superior iliac spine, behind the inguinal ligament, and descends over the surface of the

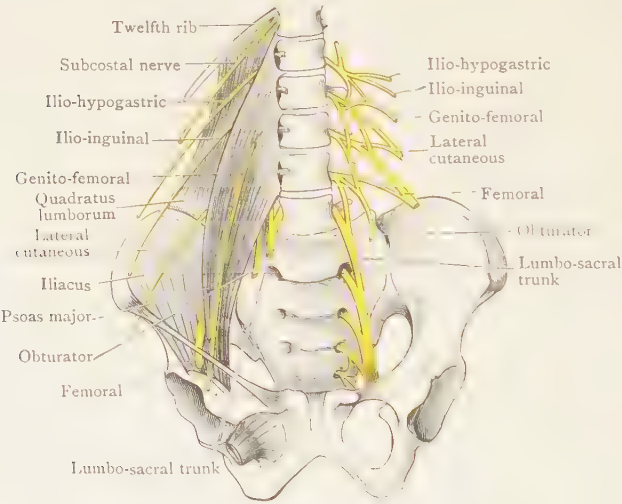


FIG. 101.—The Lumbar Plexus (semi-diagrammatic).

sartorius muscle, embedded in a thick ridge of deep fascia which must be slit up to expose the nerve. Two inches below the anterior superior spine, the nerve divides into two branches—an anterior and a posterior. The *posterior branch* pierces the deep fascia at once, and runs backwards and downwards to supply the skin over the greater trochanter and the adjoining part of the gluteal region and thigh. The *anterior branch* is longer. It pierces the deep fascia two inches lower down, and descends to the lateral side of the patella, giving branches to the skin of the lateral side and front of the thigh.

The **intermediate cutaneous nerve of the thigh** pierces the

deep fascia in the middle line of the thigh about three or four inches below the inguinal ligament. It appears usually as two branches which perforate the fascia near each other. Both branches extend to the knee.

The **medial cutaneous nerve of the thigh** also divides into two portions—an anterior and a posterior—which perforate the deep fascia on the medial side of the thigh at some distance from each other. The *anterior division* emerges at the junction of the lower and middle thirds of the thigh, in front of the long saphenous vein; it descends to the knee, and its terminal branches turn forwards to reach the front of the patella. The *posterior division* reaches the surface near the knee, behind the long saphenous vein, and descends to supply the skin on the medial side of the upper part of the leg. But the main stem of the medial cutaneous nerve sends a few twigs also to the skin of the middle third of the medial side of the thigh. These make their appearance along the line of the long saphenous vein.

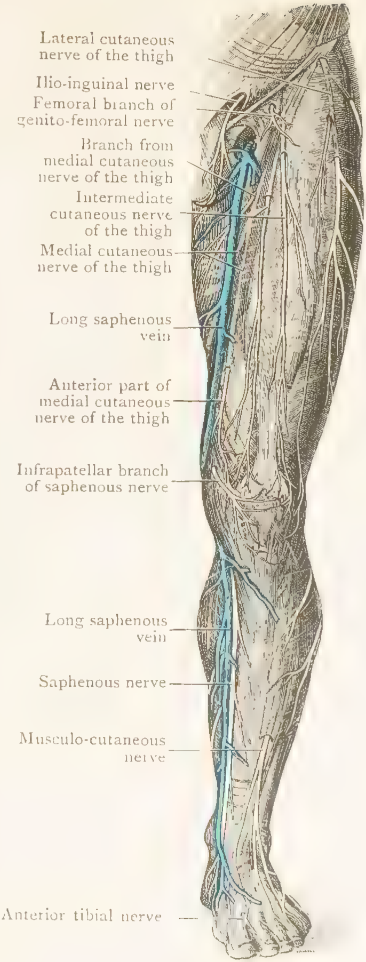


FIG. 102.—Cutaneous Nerves on the Front of the Lower Limb.

The **saphenous nerve** becomes subcutaneous on the medial side of the knee by perforating the fascia between the

sartorius and the tendon of a muscle called the gracilis, and passes into the leg in front of the long saphenous vein. The guide to it is a small artery called the *saphenous branch* of the *descending genicular artery*, which runs downwards alongside it. Before the saphenous nerve pierces the fascia it gives off an infrapatellar branch.

The *infrapatellar branch* pierces the sartorius muscle and the deep fascia on the medial side of the knee, and curves downwards and forwards over the medial femoral condyle and antero-medial surface of the knee joint (opposite the semilunar cartilage in the interior of the knee) to reach the front of the joint, below the patella (Fig. 102).

Patellar Plexus.—Twigs of four nerves have been traced to the skin of the knee, viz., the saphenous, the intermediate cutaneous, and the anterior divisions of the lateral and medial cutaneous nerves of the thigh. These nerves communicate with one another and form an interlacement, termed the *patellar plexus*, which is situated over the patella, the ligamentum patellæ, and proximal part of the tibia.

> ***Dissection.***—Remove the remains of the superficial fascia, in order to expose the deep fascia, but leave the cutaneous nerves and vessels. On the medial side of the thigh, the deep fascia is very thin, and you must take care not to remove it with the superficial fascia. As you remove the superficial fascia from the front of the knee, look again for evidence of synovial bursæ between the superficial fascia and the skin and under cover of the superficial fascia.

Fascia Lata. The **deep fascia of the thigh** is called the fascia lata. Only a portion of it is displayed at present, but the dissector should obtain a general idea of its attachments and parts before proceeding further with the dissection. One of its striking features is the marked difference in strength which it shows on the lateral and the medial sides of the thigh.

On the medial side the fascia lata is so delicate and thin that the subjacent muscular fibres shine through it. *On the lateral side* it is very dense and is thickened to form a long, strong, wide band called the **ilio-tibial tract**, which stretches from the tubercle of the iliac crest to the lateral condyle of the tibia.

Around the root of the limb, the fascia lata is attached to the inguinal and sacro-tuberous ligaments and the bones of the pelvis. Thus, it is attached, *laterally*, to the anterior part of the iliac crest; *anteriorly*, to the inguinal ligament;

medially, to the body of the pubis, to the margin of the pubic arch and to the ischial tuberosity; while *posteriorly*, it is continuous with the fascia of the gluteal region, through which it is fixed to the sacro-tuberous ligament, the coccyx, the sacrum, and the iliac crest.

Just below the inguinal ligament, it gives a linear attachment to the membranous layer of the superficial fascia; and it is modified by the formation of the cribriform fascia and the saphenous opening.

At the knee, *on the front and on the sides*, it is attached to the capsule of the knee joint, the medial and lateral margins of the patella, the tubercle of the tibia, the condyles of the tibia and of the femur, and to the head of the fibula. *Posteriorly*, it is stronger; it roofs over the popliteal fossa, where it is called the *popliteal fascia*; and it is continuous with the fascia of the back of the leg.

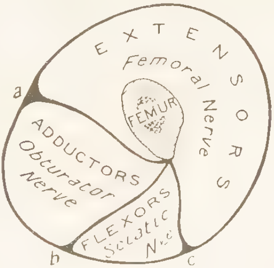


FIG. 103.—Diagram to show the arrangement of the three intermuscular septa and the three osteo-fascial compartments of the thigh. (After Turner.)

a. Medial intermuscular septum.
b. Posterior intermuscular septum.
c. Lateral intermuscular septum.

Intermuscular Septa.—The fascia lata has other offices to perform besides that of investing the thigh and preserving its figure. From its deep surface thin sheets pass into the limb and divide to form sheaths for the muscles and other structures.

The chief of these sheets are three partitions which pass from the fascia lata to the back of the femur. They are called the *lateral*, *medial* and *posterior intermuscular septa*. They divide the thigh into three compartments for the three great groups of muscles of the thigh, each associated with its nerve:—The **extensors** on the front, with the *femoral nerve*; the **flexors** or hamstrings on the back, with the *sciatic nerve*; and the **adductors** on the medial side, with the *obturator nerve*. The extensors are separated from the flexors by the lateral septum, and from the adductors by the medial septum; while the posterior septum intervenes between the adductors and the flexors (Fig. 103).

These three septa will be disclosed in the subsequent dissection. In the meantime, note that the medial and the lateral

septa show as white lines on the surface of the fascia, in the distal part of the thigh.

The extensor group is composed of four large muscles which collectively are called the **quadriceps femoris**, for they unite together before their insertion into the patella, and, therefore, resemble four heads of a single muscle. The ligamentum patellæ anchors the patella to the tibia, and acts as a continuation of the tendon of the quadriceps. A thin tendinous sheet extends downwards over the front of the patella from the tendon of the quadriceps to the ligamentum patellæ.

Dissection.- Cut across the fascia lata just above the patella, and see if there is a synovial bursa between the fascia and the tendon of the quadriceps. Then, cut through the thin tendinous sheet in front of the patella and see whether it is fused with the periosteum or whether they are separated by a synovial bursa.

Patellar Bursæ.—Several synovial bursæ are situated in the patellar region, but only two of them are constant. One or more of the others are usually present, but all of them are seldom found in the same limb. The two constant bursæ are beyond the range of the present dissection. They are :—

1. A large **suprapatellar bursa** that lies just above the patella between the tendon of the quadriceps and the front of the femur. It is important in that it nearly always opens into the cavity of the knee joint.
2. A small **deep infrapatellar bursa** placed between the lower end of the ligamentum patellæ and the upper end of the tibia.

Some of the other bursæ may have been found in the present dissection. They are :—

3. A **subcutaneous prepatellar bursa** which lies between the skin and the superficial fascia in front of the lower part of the patella, and is often present.
4. A **subfascial prepatellar bursa** and (5) a **subtendinous prepatellar bursa** which are seldom found.
6. A **subcutaneous infrapatellar bursa** which is usually present and is apt to become inflamed. It lies between the skin and the fascia in front of the tubercle of the tibia and lower half of the ligamentum patellæ, and is sometimes divided into upper and lower parts.

Deep Dissection of Front of Thigh

In this dissection, the structures to be examined are :—

1. Femoral sheath.
2. Femoral branch of genito-femoral nerve.
3. Lateral cutaneous nerve of thigh.
4. Sartorius muscle.
5. Femoral nerve and its branches.
6. Femoral artery and its branches.
7. Femoral vein.
8. Ilio-psoas { Iliacus. Psoas major.
9. Quadriceps femoris { Rectus femoris. Vastus lateralis. Vastus intermedius. Vastus medialis.
10. Articularis genu.
11. Tensor fasciæ latæ.
12. Deep part of ilio-tibial tract.
13. Lateral and medial intermuscular septa.

Inguinal Ligament. –This ligament belongs to the Abdominal wall, but the dissector of the Lower Limb must obtain some knowledge of its connexions before he proceeds further with his dissection.

The **inguinal ligament** is the thickened lower border of the aponeurosis of the external oblique muscle of the abdomen folded backwards upon itself. Therefore, it presents a rounded surface towards the thigh, and a grooved surface towards the abdomen. Its lateral extremity is fixed to the anterior superior iliac spine. Medially, it is attached to the pubic tubercle, and to the adjoining part of the pectineal line for nearly an inch. The inguinal ligament pursues an oblique course between its iliac and pubic attachments, and at the same time describes a gentle curve which is convex downwards. The fascia lata is attached to it along its whole length, and exercises traction upon it, and therefore, when the fascia lata is divided, the ligament loses its curvature.

The portion of the inguinal ligament which is attached to the pectineal line is a thin expansion from its medial part, and is called the *pectineal part of the inguinal ligament* (Fig. 104). This pectineal part is triangular in outline. One margin is continuous with the main ligament ; the other is attached to the pectineal line. The apex is at the pubic tubercle. Its base, which looks in a lateral direction, is sharp, crescentic and free, and abuts against the femoral sheath. It is set obliquely, so that its femoral surface looks downwards and laterally, and this surface gives partial origin to the pectineus muscle.

The point on the inguinal ligament which is equidistant from the pubic symphysis and the anterior superior iliac spine is called the **mid-inguinal point**.

Dissection.—The *femoral sheath* was partly exposed when the cribriform fascia was removed (p. 215). To expose the sheath fully, cut through the fascia lata along the inguinal ligament, and carefully remove the part of it that is lateral to the saphenous opening (including the falciform margin). The removal of the loose fat will then bring the whole sheath into view. With the handle of the knife or a blunt hook, isolate the sheath from the inguinal ligament and its pectineal part.

FIG. 104.—Dissection to show the connexions of the Inguinal Ligament.

Femoral Sheath. The femoral sheath is a funnel-shaped, fascial tube that surrounds the uppermost inch and a half of the femoral vessels. The mouth of the funnel opens into the abdomen; the narrow, lower part gradually closes upon the vessels, and fuses with their coats about the level of the lower margin of the saphenous opening. The sides of the sheath do not slope equally towards each other. The lateral wall is nearly vertical; the upper part of the medial wall is very oblique. If the dissection has been successfully performed, the *femoral branch of the genito-femoral nerve* is seen piercing the lateral wall of the sheath, whilst the super-

ficial branches of the femoral artery, the long saphenous vein and some lymph vessels perforate its anterior wall.

Constitution of the Femoral Sheath.—The sources from which the femoral sheath is derived, and the manner in which it is formed, must next be considered. This entails the study of some of the structures that form the walls of the abdomen.

The main part of the inguinal ligament is separated from

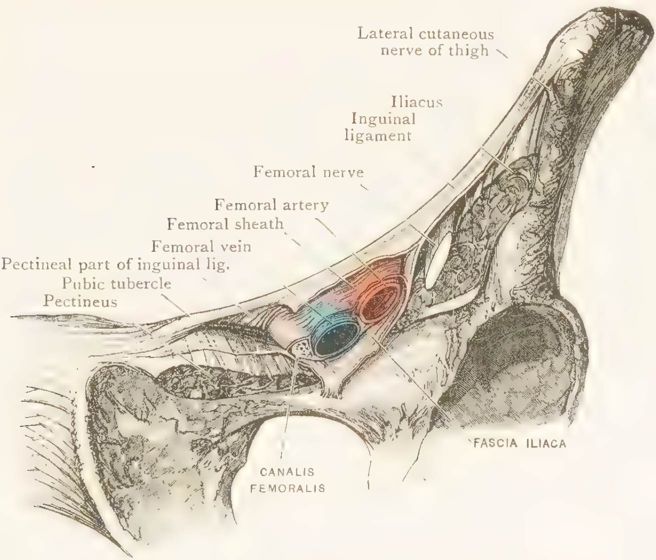


FIG. 105.—Dissection to show the Femoral Sheath and the Structures which pass between the Inguinal Ligament and the Hip Bone.

the hip bone by an elongated interval (Fig. 104). The most medial part of the interval is occupied by the *pectineal part of the inguinal ligament.* The rest of it is filled with muscles and vessels and nerves. Thus, from medial to lateral end of the interval, there are a portion of the *pectineus*, the *psoas major* and the *iliacus* muscles; the *femoral vessels* are in the space that separates the inguinal ligament from the pectineus and the psoas. The *femoral branch of the genito-femoral nerve* descends along the lateral side of the femoral artery; the *femoral nerve* is between the psoas and the iliacus; the *lateral*

cutaneous nerve is between the iliacus and the lateral end of the inguinal ligament.

The arrangement of the fascial lining of the abdominal cavity at this interval of communication between abdomen and thigh also requires attention. The lower part of the posterior wall of the abdomen, immediately above the thigh, is formed by the iliacus and psoas major muscles. They are covered with that part of the fascial lining of the abdomen which receives the name *fascia iliaca*. The anterior wall of the abdomen is lined, in like manner, with a portion of the general lining termed the *fascia transversalis*. Lateral to the femoral vessels, these two fascial layers become continuous with each other, and, at the same time, are attached to the back of the inguinal ligament (Fig. 99). It is behind this union that the iliacus, the femoral nerve, and the lateral cutaneous nerve are carried into the thigh. But the external iliac vessels (which become the femoral vessels in the thigh), with the femoral branch of the genito-femoral nerve lie anterior to the fascia iliaca, or, in other words, within the fascial lining of the abdomen; and, as they pass through the lining, behind the inguinal ligament, they carry with them a funnel-shaped prolongation of the lining, which is the femoral sheath.

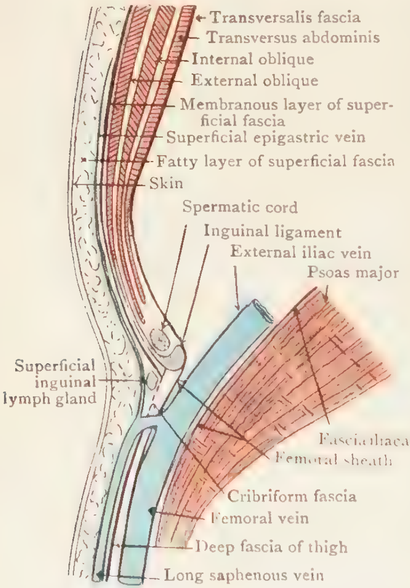


FIG. 106.—Diagram of the Fasciæ and Muscles of the Inguinal and Subinguinal Regions in the line of the femoral vein.

The dissector will now readily understand that the *anterior wall* of the sheath is formed of *fascia transversalis*, while the *posterior wall* is formed of *fascia iliaca*—each of them being

continued into the thigh from the corresponding wall of the abdomen (Fig. 106). From the posterior wall of the sheath a thin fibrous sheet passes backwards and laterally, between the pectineus and the psoas major to be connected with the capsule of the hip joint (Fig. 108).

Dissection.—Open the femoral sheath by three vertical and parallel incisions through the anterior wall—one over the femoral artery, another over the femoral vein in the line of the great saphenous vein, and the third a little medial to the upper part of the vein. The first two should begin at the inguinal ligament, and extend downwards for an inch and a half. The most medial should begin at the same level, but should be carried downwards for only half an inch or less.

Interior of the Femoral Sheath.—A little dissection will show that the sheath is subdivided, by two antero-posterior partitions, into three compartments. The femoral artery and femoral branch of the genito-femoral nerve occupy the *lateral compartment*; the femoral vein fills the *intermediate compartment*; the *medial compartment* lodges a little loose areolar tissue, a small lymph gland, and some lymph vessels. This last compartment, from its relation to femoral hernia, has the special name of *femoral canal* applied to it.

Femoral Canal.—The boundaries and extent of the femoral canal must be very thoroughly studied. The best way to begin is to introduce the little finger into the canal and push it gently upwards. The length of the canal is not nearly so great as that of the other two compartments. Indeed, it is not more than half an inch long. It rapidly diminishes in width from above downwards, and its lower end is closed by the fusion of its medial wall with the septum between it and the vein.

The upper end or mouth of the canal is called the **femoral ring**. It is wide enough to admit the tip of the little finger; and it is closed by a plug of fat called the *femoral septum*. With your finger-tip in the ring, feel its boundaries:—*anteriorly*, the inguinal ligament; *medially*, the pectineal part of that ligament; *posteriorly*, the pectineal line of the pubic bone; *laterally*, the femoral vein. The peritoneum—the innermost, glistening lining of the abdominal walls—overlies the ring, and is slightly dimpled into it; and the plug of fat that forms the femoral septum is part of what is called the extra-peritoneal fatty tissue.

The canal lies on the pectineus muscle and its fascia; the

deep external pudendal artery is usually below the canal, but may cross behind it. The upper margin of the saphenous opening crosses the upper part of the canal. Lower down, the canal is covered by the cribriform fascia, and is usually crossed by the superficial external pudendal artery.

Femoral Hernia.—Femoral hernia is the name applied to a pathological condition produced by the protrusion of some of the contents of the abdominal cavity into the thigh. As they descend they pass behind the inguinal ligament into the *femoral canal*. The arrangement of the parts which occupy the interval between the hip bone and the inguinal ligament has been carefully considered, and the dissector should therefore be in a position to understand how the occurrence of such a protrusion is possible. On the medial side of the femoral sheath, the interval is closed by the pectineal part of the inguinal ligament, which, by its strength and firm connexions, constitutes an impassable barrier. On the lateral side of the sheath, a hernial protrusion is equally impossible. There, the fascia transversalis on the anterior wall of the abdomen becomes continuous with the fascia iliaca on the posterior wall, and, along the line of union, both are firmly attached to the inguinal ligament.

It is in the region of the femoral sheath, then, that femoral hernia takes place. The three compartments of the sheath open above into the abdominal cavity, but there is an essential difference between the medial opening and the other two. The lateral two are occupied by the artery and the vein. The femoral canal, or most medial compartment, is occupied by fat which yields under pressure. Further, its widest part is the upper opening or *femoral ring*. It has been noted that the ring is wide enough to admit the point of the little finger, and it forms a weak point in the parietes of the abdomen—weaker in the female than in the male, seeing that, in the female, the distance between the iliac spine and the pubic tubercle is relatively greater, and that, in consequence, the femoral ring is wider. Femoral hernia, therefore, is more common in the female (Fig. 105).

When attempts are made to reduce a femoral hernia, it is necessary that the course which the protrusion has taken should be kept constantly before the mind of the operator. In the first instance, it passes downwards for a short distance. It then turns forwards and bulges through the saphenous opening. Should it still continue to enlarge, it first bends upwards over the inguinal ligament, and then pushes its way upwards and laterally towards the anterior superior iliac spine. The protrusion is thus bent upon itself, and, if it is to be reduced successfully, it must be made to retrace its steps. In other words, it must be drawn down, and then pushed gently backwards and upwards. The position of the limb during this procedure must be attended to. When the thigh is fully extended and rotated laterally all the fascial structures in the neighbourhood of the femoral canal are rendered tense. When, on the other hand, the limb is flexed at the hip joint and rotated medially, the upper margin of the saphenous opening, and even the pectineal part of the inguinal ligament, are relaxed. That, then, is the position in which the limb should be placed during the reduction of the hernia.

As the hernia descends it carries before it the various layers which it meets. First it pushes before it the peritoneum, and that forms the *hernial sac*. The *coverings* of the sac, from within outwards, are—(1) the femoral septum; (2) the wall of the femoral sheath; (3) the cribriform fascia; and lastly, (4) the superficial fascia and skin.

The femoral canal, as already noted, is surrounded by very unyielding structures. Strangulation of femoral hernia (*i.e.* cutting off the blood supply of its contents) due to pressure is, therefore, of very common occurrence. The sharp, tense base of the pectineal part of the inguinal ligament and the upper margin of the saphenous opening are especially apt to bring about that condition.

Abnormal Obturator Artery.—The account of the surgical anatomy of femoral hernia cannot be complete without mention of the relation which the obturator artery frequently bears to the femoral ring. In two out of every five subjects the obturator artery, on one or on both sides, takes origin from the inferior epigastric artery (as an enlargement of the pubic branch of that artery). It must then pass behind the pubic bone to gain the upper part of the obturator foramen, and according to the point at which it arises from the epigastric trunk, it presents different relations to the femoral ring. Usually, it lies in close contact with the external iliac vein on the lateral side of the femoral ring; and in that position, it is in no danger of being wounded in operations undertaken for the relief of an irreducible femoral hernia. In about thirty-seven per cent., however, of the cases in which it exists, the artery is placed less favourably. Either it passes medially, across the femoral septum, or it arches above the septum and turns backwards, on the medial side of the ring, upon the deep aspect of the base of the pectineal part of the inguinal ligament. In the latter situation, it is in a position of great danger, seeing that it is the base of the pectineal part of the inguinal ligament against which the surgeon's knife is generally directed for the relief of an irreducible femoral hernia.

The boundaries and contents of the femoral triangle, which occupies the upper third of the front of the thigh, must now be dissected.

Dissection.—Begin by cleaning the boundaries. The lateral boundary is the sartorius muscle, and the medial boundary is the medial border of a muscle called the adductor longus.

The *sartorius* is a long, strap-like muscle that extends obliquely from the anterior superior iliac spine to the medial side of the limb. Begin at the spine and clean the muscle down to the point where it crosses the adductor longus—taking care not to injure the nerves near it.

Next, clean the fascia from the front of the *adductor longus* down to the point where it disappears behind the sartorius.

Now, place a block under the knee in order to flex the hip joint and relax the boundaries and contents of the triangle.

Find the *femoral nerve*, deeply sunk in the groove between the psoas major and the iliacus. Raise the nerve on a blunt hook; it soon ends in a number of muscular and cutaneous branches. Secure the *nerve to the pectineus* first, for it is liable to injury. Trace it medially, behind the femoral vessels, into the pectineus muscle. Then, trace and clean the other branches of the femoral nerve till they leave the triangle, avoiding injury to the *lateral circumflex artery*, which passes laterally among these nerves near their origin.

Now, turn to the vessels. Clean all the arteries except the smaller branches to muscles, which may be cut if they are in the way. Clean and keep the large venous trunks, but remove the venæ comitantes of the smaller arteries.

The superficial branches of the *femoral artery* have been cleaned already in the greater part of their course. Clean the parts of them that are near their origins. Then, raise the femoral artery, and clean it from above downwards as far as the apex of the triangle. Secure and clean a small artery called the *deep external pudendal*. It springs from the upper part of the femoral artery and runs medially. You have probably found the root of the *profunda artery* already. It is a large artery that springs from the femoral artery about two inches below the inguinal ligament. Follow it downwards, amidst the fat behind the femoral vessels, till it leaves the triangle. At the same time, clean the *profunda vein*, which lies in front of its artery. Two large arteries spring from the profunda near its origin. They are the *lateral* and *medial circumflex arteries*. Trace the lateral artery as far as the sartorius. Trace the medial one backwards as far as possible into the fat behind the femoral vessels. Preserve the proximal parts of the circumflex veins, and note that they end in the femoral vein. Not uncommonly, one or both of the circumflex arteries spring from the femoral artery.

Clean the femoral vein, avoiding injuring the nerve to the pectineus, which crosses behind the vein. As you follow the vein downwards, note that it passes behind the femoral artery.

Now, remove the remainder of the fascia from the anterior surface of the adductor longus and of the pectineus As you do so, look in the interval between them for the anterior division of the *obturator nerve* ; it descends across the front of the *adductor brevis* muscle, which lies behind the pectineus and adductor longus.

Next, clean the surface of the iliacus and psoas major. And, lastly, remove the mass of fat from the angle between the psoas and pectineus – disentangling the medial circumflex artery, which passes backwards between those two muscles.

Femoral Triangle.– This is the name given to the hollow that occupies a great part of the upper third of the thigh (Fig. 107). Its *base* is the inguinal ligament. Its *lateral boundary* is the medial border of the sartorius ; its *medial boundary* is the medial border of the adductor longus ; and those two muscles meet at the *apex*. The apex is continuous with a narrow intermuscular space, called the *subsartorial canal*, through which the femoral vessels travel down to the popliteal fossa.

The *roof* is composed of the skin, the superficial fascia and the deep fascia (including the cribriform fascia). The superficial fascia contains the superficial inguinal lymph glands with their lymph vessels, the femoral branch of the genitofemoral nerve, branches of the ilio-inguinal nerve, the superficial branches of the femoral artery with their companion veins, and the upper part of the saphenous vein ; most of which pierce the deep fascia of the roof.

The *floor* is composed of muscles—adductor longus, pectineus, psoas major and iliacus, from medial to lateral side. Note that the adductor longus forms part of the floor as well as the medial boundary. Occasionally, a portion of the adductor brevis appears in the floor between the pectineus and adductor longus. The floor slopes backwards towards

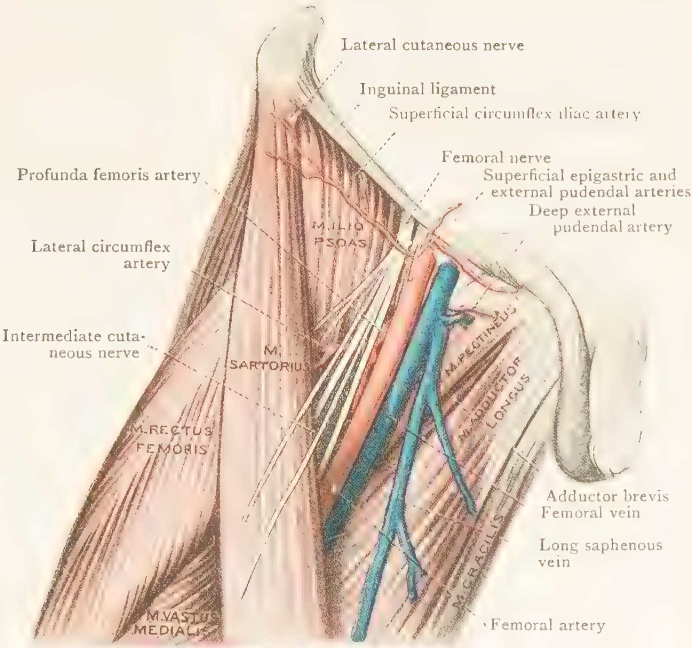


FIG. 107.—Dissection of the Femoral Triangle of the right side.

the centre from the lateral and medial boundaries; the space is triangular therefore in section as well as in superficial outline. The central hollow is between the psoas and the pectineus; it is occupied by a mass of fat containing the profunda and medial circumflex vessels, behind the femoral vessels.

The main **contents** of the triangle are as follows:—

1. The **femoral vessels** traverse the triangle from base to apex; the vein is medial to the artery at the base of the triangle, and behind it

at the apex; the *superficial branches* of the artery leave the triangle at once by piercing its fascial roof.

2. The **deep external pudendal artery** is a small artery that arises from the medial side of the femoral artery at a varying point near the base of the triangle. It runs medially in front of or behind the femoral vein, across the pectineus and the adductor longus, and pierces the deep fascia to be distributed to the scrotum in the male and to the labium majus in the female. It sometimes passes behind the adductor longus.
3. The **profunda artery** springs from the lateral side of the femoral, curves downwards behind it and leaves the triangle by passing behind the adductor longus close to the femur. The **profunda vein** is in front of its artery and ends in the femoral vein.
4. The **lateral** and **medial circumflex arteries** spring from the profunda near its origin. The lateral artery runs laterally among the branches of the femoral nerve and disappears behind the lateral boundary of the triangle. The medial artery passes backwards and disappears through the floor of the triangle between the psoas and the pectineus. The **circumflex veins** end in the femoral vein.
5. Three or four **deep inguinal lymph glands** lie along the medial side of the femoral vein. They receive afferent vessels from the superficial inguinal glands and from the deep parts of the limb; and they send their efferent vessels to the glands that lie in the abdomen around the external iliac artery.
6. The **femoral branch of the genito-femoral nerve** enters the thigh along the lateral side of the femoral artery, pierces the femoral sheath and the deep fascia about an inch below the inguinal ligament, and is distributed to the skin over the femoral triangle.
7. The **femoral nerve** enters the thigh nearly a finger's breadth lateral to the femoral artery. It lies in the groove between the iliacus and psoas major, and soon divides into branches.
8. The **lateral cutaneous nerve** of the thigh crosses the lateral angle of the triangle; it has been examined already (p. 220).

Before the contents of the triangle are studied further, another stage of the dissection of the front of the thigh must be carried out.

Dissection. Complete the cleaning of the *sartorius*—again avoiding injury to the nerves that are related to it.

Next, make a vertical cut through the deep fascia from the front part of the tubercle of the iliac crest to the lateral margin of the patella; the incision will correspond approximately to the anterior margin of the ilio-tibial tract. Then, remove the deep fascia from all the area between the incision and the sartorius.

The muscles disclosed are: (*a*) the *tensor fasciæ latæ*, on the lateral side of the upper part of the sartorius; (*b*) the *rectus femoris*, extending down the middle of the thigh; (*c*) part of a large muscle called the *vastus lateralis*, at the lateral side of the rectus (*d*) a small part of another large muscle called the *vastus intermedius* is below the vastus lateralis, but usually appears to be merely its lower part; (*e*) part of a third large muscle called the *vastus medialis* fills the space between the lower parts of the rectus femoris and sartorius.

Find the *lateral circumflex artery* again, trace it behind the sartorius and the rectus femoris, and follow its three branches;

the one that descends along the anterior border of the vastus lateralis is the guide to that border when the vasti are fused.

Separate the sartorius and the tensor fasciæ latæ; evert the tensor and look for its nerve a little above its middle. The nerve is a branch of the *superior gluteal nerve.* Follow it backwards; it disappears between two muscles of the gluteal region called *gluteus medius* and *gluteus minimus.*

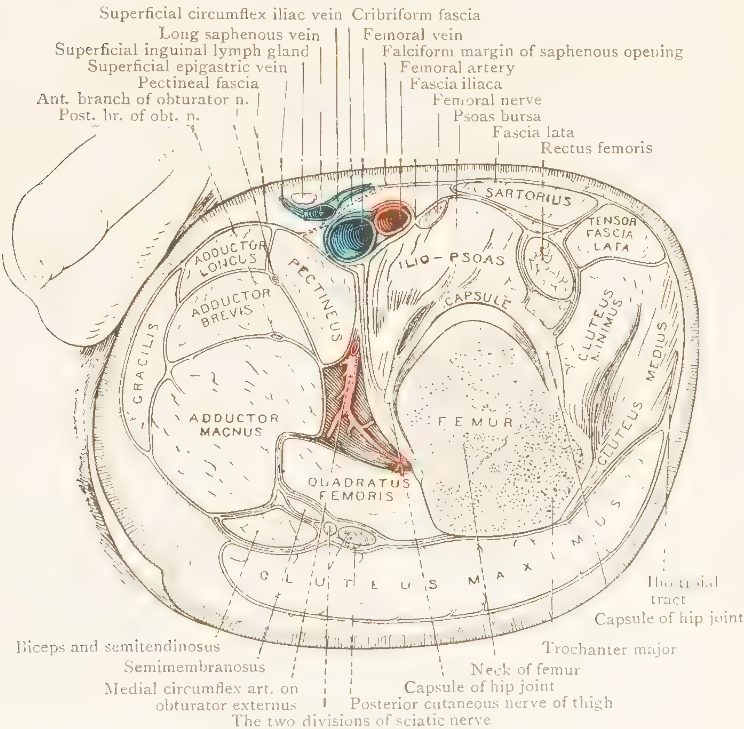


FIG. 108.—Dissection of an oblique transverse Section through upper part of Thigh showing the relation of the Fascia to the Muscles.

Now, clean the *ascending branch of the lateral circumflex artery,* and, as you remove the fat, remove also the septum of fascia which passes backwards between the sartorius and the tensor to clothe the deep surface of the tensor. Then, clean the upper part of the *rectus femoris.* It arises by two heads which very soon join together. Follow them up to their attachments.

Come back to the anterior borders of the *gluteus medius* and *minimus*: define and clean them. They are often partly fused together; but the nerve to the tensor, emerging from between them, is the guide to the line of separation. The gluteus medius

is often fused also with the deep surface of the tensor. If that is the case, separate them with the knife.

Turn now to the middle third of the medial side of the thigh. Pull the sartorius laterally. Under cover of the muscle there is a ribbon of fibrous tissue whose edges are attached to the vastus medialis and to the adductors, and it roofs over the *subsartorial canal*. Look for a plexus of delicate nerves (the *subsartorial plexus*) in the areolar tissue on this fibrous roof ; then clean the roof. Superiorly it fades away near the apex of the femoral triangle ; inferiorly it ends in a sharp, curved margin.

Lastly, split the fibrous roof, and clean the contents of the canal —femoral vessels, saphenous nerve, and nerve to vastus medialis.

Sartorius.—This is a long slender muscle whose fibres are parallel to its borders—a characteristic that enables it to be recognised when a portion of it is exposed in the living limb.

It arises chiefly from the anterior superior iliac spine, crosses the upper third of the thigh obliquely, then descends almost vertically to the posterior part of the medial side of the knee, and finally, curving forwards, it ends in a thin tendon which expands to be inserted into the upper part of the medial surface of the tibia (Fig. 125, p. 285). Note that the muscle is fleshy almost to its lower end.

Its upper, oblique part is the lateral boundary of the femoral triangle, and lies in front of the iliacus, rectus femoris and adductor longus. Next, it covers the fibrous roof of the subsartorial canal, superficial to the lower half of the femoral vessels. At the knee, when the limb is extended, it produces a vertical fleshy ridge far back on the medial side of the knee, and has to curve forwards to its insertion ; but when the leg is flexed, it slips backwards into the medial boundary of the popliteal fossa, and proceeds straight to its insertion. Its expanded tendon is superficial to the tendons of the gracilis and semitendinosus, but is separated from them by a bursa ; and it is inserted in front of them.

The sartorius is supplied by the *femoral nerve*. It acts on both the hip joint and the knee joint, and comes into prominence when those joints are flexed and the thighs are rotated to bring the limbs into the position adopted by the working tailor. (*Sartor* = a tailor).

Subsartorial Canal (Adductor Canal).—When the femoral artery leaves the femoral triangle, it is continued downwards, on the medial side of the thigh, in a deep furrow which is bounded anteriorly by the vastus medialis muscle, and posteriorly by the adductor longus and magnus muscles.

At its upper end, this furrow is continuous with the deeper, wider, and more apparent hollow which has been described as the femoral triangle. Further, the furrow is converted into a canal, triangular on cross section, by a strong

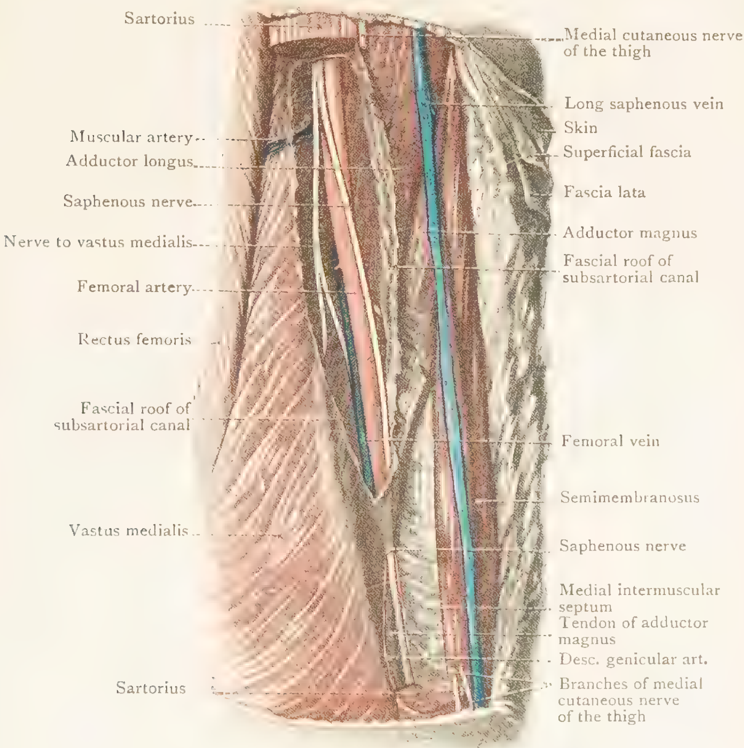


FIG. 109.—Dissection of the Subsartorial Canal in the right lower limb. A portion of the Sartorius has been removed.

fibrous membrane which stretches across it, and upon the surface of which the sartorius muscle is placed (Fig. 110). The tunnel thus formed is called the *subsartorial canal*.[1]

[1] Long known as *Hunter's Canal*. JOHN HUNTER'S (1728–1793) operation for the cure of popliteal aneurysm by ligature of the femoral artery in this canal is a landmark in the history of vascular surgery.

The fibrous membrane which roofs in the canal stretches from the fascial covering of the adductors to the fascial covering of the vastus medialis. When it is traced upwards, it is seen to become thin and ill-defined ; inferiorly, however, it becomes dense and strong, and at the distal end of the canal, it presents a thick, sharply defined margin. The posterior wall of the canal, in its lowest part, where it is formed by the adductor magnus, presents a deficiency or aperture which leads backwards into the popliteal fossa. The appearance and construction of this aperture will be studied at a later stage. It is called the *opening in the adductor magnus*.

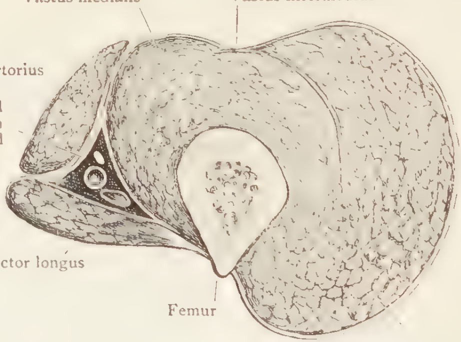


FIG. 110.—Transverse Section through the Subsartorial Canal.

The femoral vessels and the saphenous nerve traverse the subsartorial canal. Whilst the femoral artery is in the canal it gives off some muscular twigs and the descending genicular artery. The femoral vessels leave the canal by inclining backwards through the opening in the adductor magnus. The saphenous nerve, accompanied by the saphenous branch of the descending genicular artery, escapes from the canal by passing under cover of the distal margin of the fibrous roof. The nerve to the vastus medialis enters the upper end of the canal, and its branches descend for some distance between the vastus and its fascia before they enter the muscle.

Femoral Artery.—The femoral artery is the direct continuation of the external iliac artery of the abdomen, and is the great arterial trunk of the lower limb. It begins behind the inguinal ligament, at the mid-inguinal point (p. 225), and

it descends, through the upper two-thirds of the thigh, to the opening in the adductor magnus, through which it passes into the popliteal fossa to become the popliteal artery. The course of the femoral artery may be marked on the surface, when the thigh is slightly flexed, abducted and rotated laterally, by the upper two-thirds of a line drawn from the mid-inguinal point to the adductor tubercle. The extent of the artery in the femoral triangle and in the subsartorial canal varies with the width of the sartorius, but usually the upper half is in the triangle and the lower half in the canal.

Relations.—The relations which the artery bears to the femur are important. As it enters the thigh it leaves the brim of the pelvis and lies in front of the medial part of the head of the femur, from both of which it is separated by the psoas major muscle. The artery is more effectively compressed opposite the brim of the pelvis than opposite the head of the femur, because the psoas opposite the brim forms a flatter bed and the vessel is less apt to slip from under the fingers. During the remainder of its course through the femoral triangle, the artery is not in close relation to the bone; it crosses in front of the angular interval between the neck and shaft of the femur. Towards the apex of the triangle, however, it comes into relation with the medial side of the shaft of the femur, being separated only by the thin, posterior part of the vastus medialis; and that position it holds to its termination.

In the femoral triangle, the vein lies along the medial side of the upper part of the artery, but takes up a position behind it in the lower part of the triangle; and both vessels are enveloped by the femoral sheath in the upper inch and a half of their extent.

The muscles *behind* the artery are, from above downwards, the psoas major, the pectineus and the adductor longus. But it is separated (1) from the psoas by the sheath and by the nerve to the pectineus, (2) from the pectineus by a mass of fat containing the profunda vessels, and (3) from the adductor longus by the femoral vein. The order of structures, from before backwards, at the apex of the triangle is femoral artery, femoral vein, adductor longus, profunda vein and profunda artery; in a stab wound at that point all four vessels may be severed.

The only structure related to the artery *medially* is the femoral vein, in the upper part of the triangle. *Lateral* to

its upper inch there are the femoral branch of the genito-femoral nerve, and (separated by a piece of the psoas major) the femoral nerve; below that, there are the saphenous and medial cutaneous nerves. *Superficially*, there are only the skin and the fasciæ and the medial cutaneous nerve, which crosses the artery at the apex of the triangle.

In the subsartorial canal, the artery is related *posteriorly* to the adductors longus and magnus; but it is separated from them by the femoral vein, which is posterior to the artery in the upper part of the canal and postero-lateral in the lower part; and the adductor longus separates the femoral vessels from the profunda vessels. The vastus medialis is *antero-lateral* to the femoral artery, and the sartorius is *antero-medial*—separated by the fibrous roof of the canal and the subsartorial plexus of nerves. The nerve to the vastus medialis is lateral to the artery in the upper part of the canal; and the saphenous nerve crosses gradually in front of the artery from lateral to medial side.

Branches.—The branches given off in the femoral triangle are the superficial circumflex iliac, the superficial epigastric, the superficial and deep external pudendal and the profunda femoris; some of them have been followed to their terminations, whilst others will be traced in later dissections. The branches which arise in the subsartorial canal are muscular twigs and the descending genicular artery.

The **descending genicular artery** springs from the femoral trunk a short distance above the opening in the adductor magnus. It gives branches to muscles and to the knee joint, and a *saphenous branch* that accompanies the saphenous nerve and supplies the skin of the medial side of the knee and the leg.

Femoral Vein.—This large vessel is the direct continuation of the popliteal vein. It begins at the opening in the adductor magnus, traverses the subsartorial canal and the femoral triangle, and ends behind the inguinal ligament, where it becomes the external iliac vein. It accompanies the femoral artery, but their relations to each other alter at different stages of their course. In the lower part of the subsartorial canal, the vein is postero-lateral to the artery; it inclines medially as it ascends, and, for a considerable distance, is directly behind the artery; but in the upper part of the femoral triangle it is on the medial side of the artery.

Slit the femoral vein open with the scissors. Several valves will then be seen. One is almost invariably found immediately above the entrance of the profunda vein.

The **tributaries** of the femoral vein do not correspond strictly to the branches of the artery. It receives the veins that accompany the muscular twigs, the descending genicular, the profunda, and the deep external pudendal artery, and, in addition, the long saphenous vein and the circumflex veins. It fails to receive the veins that accompany the superficial arteries that arise from the upper end of the femoral artery. These veins end in the long saphenous vein, and are comparable to the veins that accompany the branches of the acromio-thoracic artery of the upper limb, which, instead of proceeding to the main vein (the axillary) end in the nearest subcutaneous stem (the cephalic vein).

Femoral Nerve.—This large nerve arises, within the abdomen, from the lumbar plexus. It descends in the groove between the iliacus and psoas major, and enters the thigh behind the inguinal ligament and the fascia iliaca. In the thigh, it lies to the lateral side of the femoral artery, and is separated from it by a small portion of the psoas major muscle and the femoral sheath (Fig. 105).

It ends about an inch below the inguinal ligament, having resolved itself into a number of muscular and cutaneous nerves :—

Muscular :	Cutaneous :
To pectineus.	Medial cutaneous, of thigh.
To sartorius.	Intermediate cutaneous, of thigh.
To quadriceps femoris.	Saphenous.

The supply to the quadriceps femoris is by separate nerves to its four heads—rectus femoris and the three vasti. The *articular* nerves arise from these four muscular branches. The nerve to the rectus femoris sends a slender branch to the hip joint, and the nerves to the vasti send filaments down through the muscles to the knee joint. Thus, the nerves to the heads of the quadriceps that act only on the knee joint send branches to that joint ; the nerve to the head that acts also on the hip joint sends a branch to that joint.

The first branches to arise are the medial and intermediate cutaneous and the nerves to the pectineus and the sartorius ; they spring from the anterior part of the femoral trunk. Then the nerves to the rectus femoris, vastus lateralis, intermedius

and medialis arise in that order from above downwards, leaving the saphenous nerve to go on as the continuation of the trunk.

The *intermediate cutaneous nerve* sometimes pierces the proximal border of the sartorius. It divides into two branches which perforate the fascia lata about three or four inches below the inguinal ligament. Their distribution has been examined already (p. 220).

The *medial cutaneous nerve* inclines downwards and medially along the medial margin of the sartorius, crosses in front of the femoral artery at the apex of the femoral triangle, and divides into an anterior and a posterior branch. The *anterior branch* crosses the sartorius muscle and makes its appearance through the fascia lata at the junction of the middle and lower thirds of the thigh, a short distance in front of the long saphenous vein. The *posterior branch* runs along the posterior border of the sartorius, and pierces the deep fascia near the knee, behind the sartorius and the saphenous nerve. The subcutaneous parts of these branches also have been studied already (p. 221).

Twigs from the posterior branch of the medial cutaneous nerve form, with filaments from the obturator nerve and the saphenous nerve, a plexiform interlacement, called the *subsartorial plexus*, which is placed deep to the sartorius muscle as it lies over the adductor canal.

The *saphenous nerve* is the longest branch of the femoral nerve. It runs downwards and medially in the femoral triangle, on the lateral side of the femoral artery; accompanies the femoral artery in the subsartorial canal, first on the lateral side of the artery and then in front of it; and emerges from the canal by passing under cover of the lower border of its fibrous roof, accompanied by the saphenous branch of the descending genicular artery. It escapes from under cover of the sartorius, at its posterior border, between the sartorius and the tendon of the gracilis; and, piercing the deep fascia at the medial side of the knee, it descends into the leg. After it quits the adductor canal, it gives off the *infrapatellar branch*, which pierces the sartorius and appears on the surface of the fascia lata on the medial side of the knee (Fig. 102).

The *nerve to the pectineus* arises a short distance below the inguinal ligament, and runs medially and downwards behind the femoral vessels to reach its destination.

The *nerves to the sartorius* are two or three in number. As

a rule, they take origin in common with the intermediate cutaneous nerve.

The *nerves to the rectus femoris* (usually two) sink into the deep surface of that muscle. The upper one supplies an articular twig to the hip joint.

The *nerve to the vastus medialis* accompanies the saphenous nerve into the subsartorial canal, and divides into branches which soon sink into the muscle. It sends an articular branch to the knee joint.

The *nerve to the vastus lateralis* passes behind the rectus femoris, and runs downwards with the descending branch of the lateral circumflex artery to enter the anterior border of the muscle. Usually it gives a twig to the knee joint.

The *nerves to the vastus intermedius* are two or three in number, and they sink into its anterior surface. The most medial of them is a long slender nerve which can be traced downwards, along the medial edge of the vastus intermedius to the *articularis genu* muscle. Its terminal twigs are given to the knee joint.

Lateral Circumflex Artery.—This is the largest branch of the profunda femoris artery. It arises near the origin of the profunda, and runs laterally, among the branches of the femoral nerve and then under cover of the sartorius, to the deep surface of the rectus femoris, where it ends by dividing into ascending, transverse, and descending branches.

The *ascending branch* reaches the gluteal surface of the ilium by ascending along the trochanteric line of the femur under cover of the tensor fasciæ latæ. It supplies the hip joint and the adjacent muscles. The *transverse branch* is of small size. It sinks backwards through the vastus lateralis, and anastomoses with other arteries at the back of the femur. The *descending branch* runs downwards along the anterior border of the vastus lateralis, gives branches to the quadriceps femoris, and sends a long branch down through the vastus lateralis to the capsule of the knee joint.

Tensor Fasciæ Latæ.—This is a short, thick muscle that lies at the junction of the gluteal region and the upper part of the front of the thigh. It is enclosed between two layers of fascia which are continuous, posteriorly and inferiorly, with the ilio-tibial tract. Both layers have been removed already. The layer on its deep surface sends processes medially to fuse with the tendon of the rectus femoris and with the capsule of the hip joint. The muscle arises from the anterior part of the iliac crest, and passes downwards and slightly backwards to be inserted into the ilio-tibial tract an inch or two below the level of the greater trochanter. It is supplied by the superior gluteal nerve.

Ilio-tibial Tract.—The thick band of fascia lata on the lateral side of the thigh which receives this name should now be examined, and its connexions ascertained.

It is attached, superiorly, to the tubercle of the iliac crest, and, inferiorly, to the lateral condyle of the tibia, the capsule of the knee and the patella. From above downwards, it lies superficial to part of the gluteus medius, the greater trochanter, the vastus lateralis, the lower lateral part of the vastus intermedius, the lateral condyle of the femur, and the knee joint.

Two muscles are inserted into it: the gluteus maximus posteriorly, at the level of the greater trochanter; and the tensor fasciæ anteriorly, below the greater trochanter. The lower part of the tract serves, therefore, as an aponeurotic tendon by means of which those two muscles gain insertion into the lateral condyle of the tibia; and the whole tract serves as a powerful brace which, in the erect posture, helps to steady the pelvis and keeps the knee joint firmly extended.

Above the insertion of the gluteus maximus, the posterior border of the tract is continuous with the thick fascia on the superficial surface of the gluteus medius, and its anterior border splits to become continuous with the two laminæ that enclose the tensor fasciæ latæ. Below the gluteus maximus, the borders of the tract merge into the rest of the fascia lata; and its deep surface is connected with the lateral supracondylar ridge and the linea aspera by the lateral intermuscular septum.

Dissection.—To see the *lateral intermuscular septum* and the relation of the vastus lateralis to the femur, detach the muscle from its origin and turn it forwards from its bed.

Intermuscular Septa.—There are three intermuscular septa of the thigh: lateral, medial, and posterior (p. 223). The lateral is strong; the other two are weak. Only the lateral and medial are to be examined at present.

The *lateral intermuscular septum* is a fibrous partition that separates the vastus lateralis and intermedius from the short head of the biceps femoris—one of the muscles of the back of the thigh. The septum springs from the deep surface of the ilio-tibial tract, and its deep border is attached to the lateral supracondylar ridge and to the linea aspera. Parts of the vastus intermedius and vastus lateralis arise

from its anterior surface, and some of the fibres of the short head of the biceps femoris spring from its posterior surface, and can be seen shining through it at this stage of the dissection.

The *medial intermuscular septum* is very thin, and it is difficult to demonstrate it. It is interposed between the adductors and the vastus medialis. Its lowest part, which is most distinct, passes laterally, from the fascia lata on the medial side of the thigh, behind the posterior border of the sartorius and behind the saphenous nerve, to the medial supracondylar ridge, and it lies in front of the distal part of the adductor magnus. Its upper part is the thin layer of fascia on the anterior surfaces of the adductors magnus and longus, and is continuous above with the pectineal fascia.

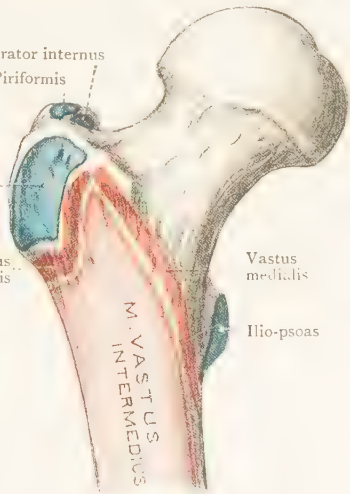


FIG. 111.—Front of upper part of Femur with Attachments of Muscles mapped out.

Quadriceps Femoris.—The quadriceps femoris muscle is composed of four portions: the *rectus femoris*, which is placed in the anterior part of the thigh, and is quite distinct from the others, except at its insertion; the *vastus lateralis*, the *vastus intermedius*, and the *vastus medialis*, which clothe the front and sides of the shaft of the femur, and are more or less blended with one another. The vasti and the rectus are all supplied by the *femoral nerve*.

The **rectus femoris** muscle arises by two tendinous heads, which were exposed when the dissection was carried deeply in the interval between the sartorius and tensor of the fascia lata (p. 235). The *straight head* springs from the anterior inferior iliac spine (Fig. 127). The *reflected head*

arises, under cover of the gluteus minimus, from a marked impression on the ilium, immediately above the acetabulum (Fig. 127); it is connected both with the capsule of the hip joint and with the fascia on the deep surface of the tensor.

At the present stage of dissection only the anterior part of the reflected head is visible; the posterior part will be seen when the gluteal region is dissected.

The two heads of origin of the rectus femoris join at a right angle, immediately beyond the margin of the acetabulum, and form a strong, flattened tendon, which gives place to a fusiform, fleshy belly. The tendon of origin spreads out on the anterior surface of the upper part of the muscle in the form of an aponeurosis. About three inches above the knee joint, the rectus femoris ends in a strong tendon of insertion which is prolonged for some distance upwards, on its deep surface, in the form of an aponeurosis. As it nears the knee the tendon of the rectus femoris joins the other tendons of the quadriceps, and forms with them a common tendon which is inserted into the upper border of the patella.

The **vastus lateralis** forms the greater part of the fleshy mass on the lateral side of the thigh. Its superficial stratum is a glistening aponeurosis. It overlaps the vastus intermedius, and is partly blended with that muscle; its anterior border is therefore ill defined, and the descending branch of the lateral circumflex artery is the best guide to it.

The vastus lateralis has a long, linear origin from the root of the greater trochanter and the back of the femur down to the supracondylar ridge (Figs. 111, 112, 128). The fleshy fibres are for the most part directed downwards and forwards. By means of the common tendon of insertion the muscle gains attachment to the patella, and, at the same time, gives an expansion to the capsule of the knee joint.

Dissection.—Divide the rectus femoris about its middle, and pull the lower part forcibly downwards. The narrow interval between the tendons of the *vastus intermedius* and *vastus medialis* will then become apparent, and will serve as a guide to the line along which the muscles must be separated. Another guide to the line of separation is the long, slender nerve of supply to the *articularis genu muscle*; it runs along the medial edge of the vastus intermedius. Raise the anterior border of the vastus medialis and pull it medially; note that so few muscle bundles arise from the medial surface of the femur that it is almost bare. Divide the vastus medialis about two inches above the patella; pull the muscle medially, and examine its origin.

The **vastus medialis** is intimately connected with the vastus intermedius, but not to such an extent as might be inferred from a superficial inspection. In its upper part, the anterior border, which is fleshy, is either contiguous to or blended with the intermedius; distally, the anterior border is tendinous and overlaps the intermedius, but it is not, as a rule, fused with it.

The vastus medialis has a long linear origin chiefly from the trochanteric and spiral lines and the linea aspera (Figs. 112, 128). The fleshy fibres are directed downwards and forwards, and end in the common tendon of the quadriceps muscle, which is inserted into the patella and becomes connected with the capsule of the knee joint.

The **vastus intermedius** covers and arises from the anterior and lateral surfaces of the shaft of the femur. It is inserted into the patella by means of the common tendon.

The *articularis genu muscle* consists of a few of the deepest bundles of the vastus intermedius. They spring from the front of the femur and are inserted into the synovial membrane of the knee as it bulges upwards between the quadriceps tendon and the bone.

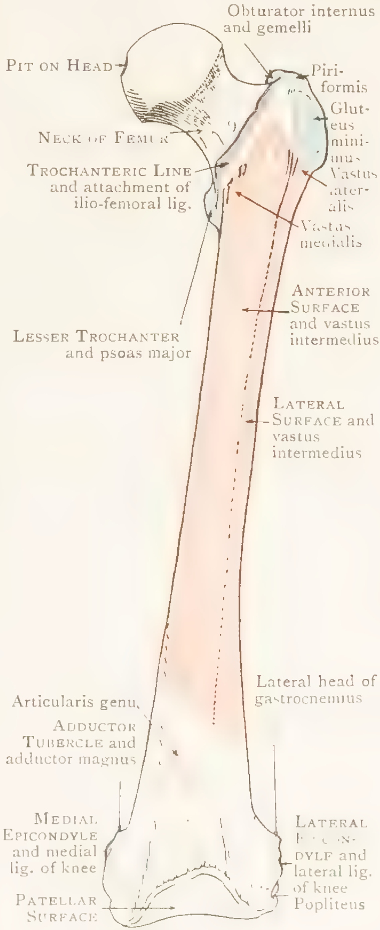


Fig. 112.—Front of Femur with muscular attachment mapped out.

Common Tendon of the Quadriceps.—It should now be noticed that the common tendon of the quadriceps muscle takes the place of the capsular ligament of the knee joint above the patella. It is inserted into the upper border of that bone; but some fibres are carried downwards, across the front of the patella, into the ligamentum patellæ.

The **ligamentum patellæ** is the broad, thick tendon that connects the patella with the tubercle of the tibia, and through which the quadriceps is attached to the tibia. It will be studied with the knee joint.

The quadriceps femoris, acting as a whole, is an extensor of the knee, but the rectus femoris can also take part in flexion of the thigh at the hip joint. The articularis genu merely lifts the upper part of the synovial membrane of the knee to prevent its being caught between the bones as the knee joint is extended.

The student whose first dissection is the Lower Limb should now revise the front of the thigh thoroughly before the body is turned face downwards. But the more experienced dissector will have time to proceed with the medial side of the thigh; he should therefore pass on to p. 280, and dissect as much as possible of that region before the body is turned.

At the end of the fifth day, the dissector must paint the various parts of the anterior and medial regions of the thigh with preservative solution, replace them in position and fix the skin flaps over them with a few points of suture.

On the morning of the sixth day after the dissection of the Lower Limb has been begun, the subject is placed upon the table with its face downwards and its thorax and pelvis supported by blocks. In that position it is allowed to remain for *five* days, and during that time the dissector of the Lower Limb has again a very extensive dissection to perform. He has to dissect (1) the gluteal region; (2) the popliteal fossa; and (3) the back of the thigh. With so much work before him, and being limited as to the time in which it must be done, it is necessary that he should apportion the five days at his disposal so as to complete the dissection before the body is turned again. The *first two days* he should devote to the study of the gluteal region; the *third* and *fourth days* may be given to the popliteal fossa; and on the *fifth day* he should undertake the dissection of the back of the thigh, and revise the work of the preceding four days.

GLUTEAL REGION

In the gluteal region, the following parts will be displayed in the course of the dissection :—

1. Superficial fascia.
2. Cutaneous nerves and blood-vessels.
3. Deep fascia.
4. Gluteus maximus (and after this has been reflected),
   - Three synovial bursæ.
   - The gluteus medius and minimus.
   - The two gemelli muscles and the tendon of the obturator internus.
   - Tendon of the obturator externus.
   - Upper border of the adductor magnus.
   - The origin of the hamstrings from the ischial tuberosity.
   - The upper part of the vastus lateralis.
5. The sacro-tuberous ligament.
6. Arteries . . .
   - Superior gluteal.
   - Inferior gluteal.
   - Internal pudendal.
   - Medial circumflex.
7. Nerves . . .
   - Superior gluteal.
   - Sciatic.
   - Posterior cutaneous, of the thigh.
   - Pudendal.
   - Nerve to obturator internus.
   - Nerve to quadratus femoris.
   - Inferior gluteal.

The **first day's work** should be—(1) Surface anatomy; (2) dissection of the parts superficial to the gluteus maximus; (3) cleaning and reflecting of that muscle; (4) tracing and defining of the various nerves and blood-vessels which enter its deep surface. **On the second day,** dissect the parts exposed by the reflexion of the gluteus maximus.

Before the skin is removed the surface markings of the gluteal region must be examined.

Surface Anatomy (Figs. 96, 113). In the lower part of the region, the **buttock** or natis forms a smooth, rounded elevation which is separated from its fellow by the deep fissure called the **natal cleft,** and is limited inferiorly by the groove called the **fold of the buttock.** The groove is the result of a firm linear attachment of the skin to the deep fascia by fibrous strands that pass through the superficial fascia. The bulging prominence of the buttock is due to a thick layer of fat and the lower part of a large muscle called the **gluteus maximus** that overlie the ischium, which is the skeleton of the buttock. The lower end of the ischium and the lower part of its posterior

surface are greatly roughened by the attachment of muscles, and the rough area is called the **ischial tuberosity.** Though the tuberosity is hidden deeply under the fat and gluteus maximus, it can be felt if you place your finger in the medial part of the fold of the buttock and press upwards.

The terms "buttock" and "gluteal region" are not synonymous. The "region" extends both upwards and forwards for a considerable distance beyond the buttock, and is limited superiorly by the **iliac crest** (p. 55). On the side of the trunk, in a muscular man, the outermost muscle of the abdomen (*obliquus externus*) bulges out over the crest so that the crest lies in a groove. Find the highest point of the crest (which is at the level of the fourth lumbar spine), and note the downward slope of the crest both anteriorly and posteriorly. Its anterior part has been examined already. A line drawn from its anterior superior spine to the front of the greater trochanter marks the anterior limit of the gluteal region, and its junction with the upper part of the front of the thigh.

Trace the iliac crest backwards and downwards to its posterior end, which is called the **posterior superior iliac spine.** This spine does not form a surface prominence; on the contrary, it lies in the floor of a dimple of the skin. The dimple is situated a little above the buttock, about three finger breadths from the median plane, and is at the level of the second spine of the sacrum, opposite the middle of the sacro-iliac joint.

The area between the right and left dimples corresponds to the back of the **sacrum.** The sacrum has usually three tubercles or spines in the median plane, about an inch apart. The second spine is midway between the dimples, and is the guide to the other two spines. The natal cleft begins at or near the third spine, and deepens as it extends downwards; the lower part of the sacrum and the coccyx lie in its floor. The **coccyx** reaches almost to the anus, and can be distinguished from the sacrum, because it moves slightly under pressure, except in old people.

Press firmly on the region between the lower part of the sacrum and the ischial tuberosity. The resistance encountered is due to a strong band, called the **sacro-tuberous ligament,** which is felt through the fat and the gluteus maximus.

The dissectors will now proceed to remove the skin.

Dissection.—Reflexion of Skin.—*Incisions* (Fig. 113).—(1) From the posterior superior iliac spine in a curved direction along the iliac crest, as far forwards as the position of the body will permit; (2) from the posterior end of this curved incision obliquely

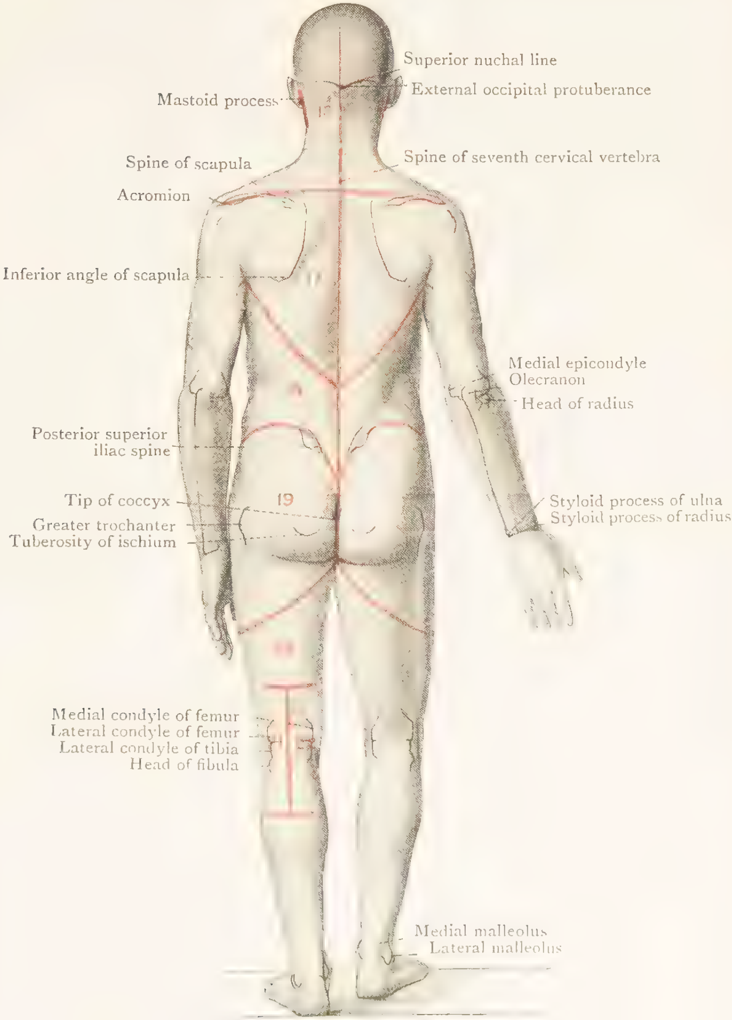


FIG. 113.—Back view of body, showing landmarks and incisions.

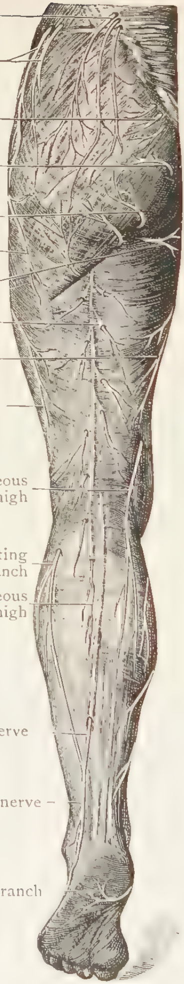


FIG. 114.—Cutaneous Nerves on the posterior aspect of the Lower Limb.

downwards and medially to the middle line of the sacral region, and then perpendicularly to the tip of the coccyx; (3) from the tip of the coccyx obliquely downwards and laterally over the back of the thigh, to the middle of the lateral side of the thigh

Raise the large flap of skin thus marked out, and throw it laterally. On the right side of the body, begin at the iliac crest and work downwards and forwards; on the left side, begin over the coccyx and work upwards and forwards.

Superficial Fascia.—This has the same general characters as the corresponding layer of fascia in other parts of the body. It presents, however, certain peculiarities. It is much more heavily laden with fat—more particularly so in the female; it thickens over the upper and lower margins of the gluteus maximus; and it is tough and stringy over the ischial tuberosity, where it forms a most efficient cushion upon which the ischium rests while the body is in the sitting posture.

Cutaneous Nerves (Fig. 114).—The cutaneous nerves of the gluteal region are numerous. Some of them are difficult to find, but the small arteries (when well injected) may serve as guides to them; if, however, the subject is obese, many of

them are so embedded in the fat, at different levels, that a satisfactory display of the whole series is not easily obtained. Therefore, the dissector who is working upon the gluteal region for the first time must not be disappointed if the final result of his work does not quite realise his hopes and expectations.

The nerve twigs distributed to the skin of the gluteal region are derived from the anterior primary ramus of the last thoracic nerve and, directly or indirectly, from the anterior and posterior primary rami of the lumbar and sacral nerves ; they ramify, as in other regions, in the superficial fascia on their way towards their terminations.

The nerves which must be sought for are—

Derived from anterior primary rami.	Perforating cutaneous nerve. Twigs from posterior cutaneous nerve of thigh. Twigs from posterior branch of lateral cutaneous nerve of thigh. Lateral branch of subcostal. Lateral branch of ilio-hypogastric.
Derived from posterior primary rami.	Branches from upper three lumbar nerves. Branches from upper three sacral nerves.

Before the dissector attempts to expose the nerves, he must consider their position and direction carefully (Fig. 114).

The *perforating cutaneous nerve* arises in the pelvis from the anterior primary rami of the second and third sacral nerves. It perforates the sacro-tuberous ligament, the gluteus maximus muscle and the deep fascia, appears in the superficial fascia about midway between the coccyx and the ischial tuberosity, and runs laterally in the lower part of the gluteal region.

Gluteal branches of the posterior cutaneous nerve, two or three, pierce the deep fascia at the middle third of the lower border of the gluteus maximus, and run upwards in the lower part of the gluteal region.

The *posterior branch of the lateral cutaneous nerve* has been found already. It pierces the deep fascia about two inches below the anterior superior iliac spine, and inclines downwards and backwards, sending twigs into the gluteal region.

The *lateral cutaneous branch of the subcostal nerve* (twelfth thoracic) pierces the deep fascia immediately in front of the tubercle of the iliac crest, and descends in the gluteal region as far as the greater trochanter.

The *lateral cutaneous branch of the ilio-hypogastric nerve* pierces the deep fascia behind the tubercle of the crest, and descends to a like level.

The *branches from the upper three lumbar posterior primary rami* pierce the deep fascia a little above the iliac crest, a little behind its highest point; they descend in the gluteal region almost to the fold of the buttock—crossing and communicating with one another as they descend.

The *branches of the upper three sacral posterior rami* pierce the deep fascia between the posterior superior iliac spine and the coccyx—about an inch apart—and supply the skin of the adjoining medial part of the gluteal region. Before they pierce the gluteus maximus they form a plexus on the surface of the sacro-tuberous ligament.

Dissection.—Seek first for the branches of the posterior primary rami of the sacral nerves. Make an incision through the superficial fascia along a line commencing a finger's breadth medial to the posterior superior iliac spine and terminating at the tip of the coccyx. Then reflect the lateral part of the superficial fascia away from the median plane and secure the nerves as they pierce the deep fascia.

The branches of the posterior primary rami of the lumbar nerves should next be sought. Make an incision half-way through the depth of the superficial fascia along the line of the iliac crest. Raise a layer of fascia, and throw it towards the trochanter major, securing twigs of the lumbar nerves as they pass from the deeper to the more superficial layers of the fascia. As soon as a twig is found, follow it towards the iliac crest; it will lead to the trunk from which the twig issues. As soon as the trunk is secured, trace it and its branches. As the branches are being cleaned, twigs from the adjacent lumbar nerves are certain to be exposed. Trace such twigs to their sources; when the parent trunks are found, follow them and their branches. If the plan outlined is followed the dissector will demonstrate the branches of the lumbar nerves without any great difficulty. He should then attempt to find the lateral branches of the ilio-hypogastric and subcostal nerves, following the same plan of search.

No time need be lost in looking for the perforating cutaneous nerve. Either it has been displayed and left *in situ* by the dissector of the perineum, or it has been removed.

The gluteal branches of the posterior cutaneous nerve of the thigh have now to be displayed. Define the position of the lower border of the gluteus maximus. It is opposite a line that begins at the coccyx and is drawn towards the lateral side of the thigh a hand's breadth below the greater trochanter. Cut through the superficial fascia along that border. Do so very carefully, for, if you cut the deep fascia also, you are apt to cut the posterior cutaneous nerve as it escapes from under cover of the gluteus maximus. As soon as the deep fascia is exposed,

turn the superficial fascia upwards, and look for the nerves as they curve upwards round the lower border of the gluteus maximus about its middle third.

After the cutaneous nerves have been demonstrated, remove the superficial fascia from the whole of the gluteal region in order that the deep fascia may be examined.

Deep Fascia.—The deep fascia now exposed differs in character in the anterior and posterior parts of its extent. In front of the gluteus maximus, where the fascia lies over the anterior part of the gluteus medius, it is dense and opaque and is pearly white in colour—in marked contrast with the deep fascia over the gluteus maximus itself, which is thin and transparent. When the dense portion reaches the anterior border of the gluteus maximus it splits into two lamellæ which enclose the muscle between them. Both lamellæ give origin to some of its fibres, and they send their septa into the muscle to divide it into coarse bundles.

Dissection.—Follow the branches of the posterior cutaneous nerve of the thigh to the trunk of that nerve at the lower border of the gluteus maximus; when the trunk of the nerve is secured, proceed to clean the gluteus maximus—a difficult process, owing to the septa of deep fascia.

The dissector of the right lower limb should begin at the upper border of the muscle and work downwards; the dissector of the left limb should work upwards from the inferior border.

Do not remove the thick, opaque fascia which covers the insertion of the muscle.

If the work is to be done well, the dissector must keep clearly before him the rules which have already been laid down regarding the cleaning of a muscle: (1) Make the fibres as tense as possible by rotating the limb; (2) define very carefully the borders of the muscle; (3) always cut in the direction of the muscular fibres.

While at work at the upper border of the muscle, lift that border, and note the connexion of the fascia with the layer on the deep surface of the muscle and with the fascia on the anterior part of the gluteus medius.

Gluteus Maximus.—The gluteus maximus is a powerful muscle which arises from—(1) the rough, upper part of the area of the ilium behind the posterior gluteal line; (2) the back of the sacrum and coccyx; and (3) the sacro-tuberous ligament.

From this extensive origin, the fasciculi of the muscle proceed obliquely downwards and forwards towards the upper part of the shaft of the femur; but only a portion of the muscle is inserted into the femur. Three-quarters of it is inserted into the ilio-tibial tract; the lower deep

quarter is inserted into the gluteal tuberosity. As the upper part approaches its insertion, it becomes aponeurotic; and this sudden thinning of the muscle accounts for the hollow of the hip behind the greater trochanter. The lower border

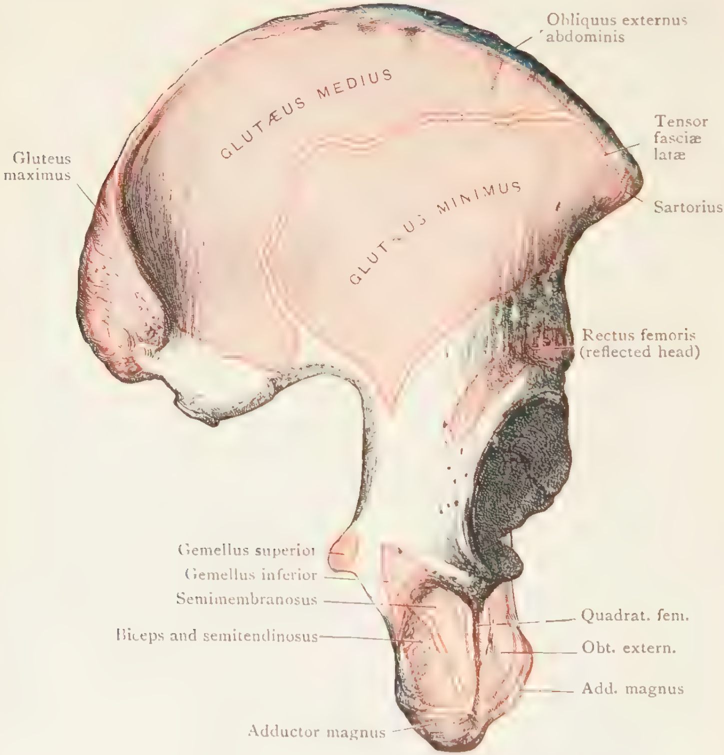


FIG. 115.—Muscle Attachments on the dorsal aspect of the Hip Bone.

of the muscle crosses the fold of the buttock obliquely, being above the medial part of the fold, but below its lateral part.

Three *synovial bursæ* underlie the muscle—(1) A multilocular bursa separates its lower edge from the tendons that arise from the ischial tuberosity, *i.e.* the origin of the hamstrings; it is usually difficult to define it, owing to the small size of its loculi and the stringiness of the fibrous tissue

between them. (2) A large bursa separates the aponeurotic part from the greater trochanter ; and (3) another large bursa separates the aponeurotic part from the upper part of the vastus lateralis.

The gluteus maximus is supplied by the *inferior gluteal nerve*. It is the chief extensor of the thigh at the hip joint and comes powerfully into action to straighten the lower limb on the trunk, or the trunk on the lower limb, in the act of rising from the stooping and squatting positions, and in walking, running and climbing. Besides acting as an extensor, it is a powerful adductor and lateral rotator. Its upper fibres, however, assist the other gluteal muscles in abduction, and also can initiate medial rotation.

Dissection.—Reflexion of the Gluteus Maximus.—As the gluteus maximus is reflected, be careful not to injure the structures which lie closely subjacent to it. The nerves most liable to injury are the *posterior cutaneous nerve* of the thigh, which has already been identified and secured, if previous instructions have been followed (see p. 254), and the *perforating cutaneous nerve*, which is very liable to injury when the fibres of the gluteus maximus are being raised from the *sacrotuberous ligament*. That ligament itself is liable to be cut if it is not identified before the medial part of the muscle is reflected.

Cut through the muscle from (1) a point on its upper border two finger-breadths above the greater trochanter to (2) a point on the lower border an inch medial to the insertion of the muscle into the femur. The procedure differs on the two sides, as the cut is made.

On the *right side*, detach the upper border, and pass two fingers downwards, separating the muscle from subjacent structures, as the cut is made. On the *left side*, detach the lower border, pass two fingers upwards, raising the muscle from subjacent structures while making the cut.

When the muscle is divided, reflect the lateral part to its insertion. As the upper fibres of the muscle are followed the two bursæ that separate its aponeurosis from the trochanter major and vastus lateralis will come into view. Open them, and explore their extent with the finger-tip.

Then, reflect the medial part of the muscle towards its origin. As the reflection proceeds, keep the edge of the scalpel close to the deep surface of the muscle to avoid injuring the posterior cutaneous nerve of the thigh ; and, as soon as the vessels and nerves which enter the muscle appear, clean and turn them medially with the muscle (removing the veins, if necessary). These vessels and nerves are :—(1) the *superficial branch of the superior gluteal artery*, encountered as the upper part of the muscle is followed towards the ilium ; and (2) the *inferior gluteal nerve and artery*, encountered as the lower part is turned towards the tuberosity of the ischium. As the muscle is lifted from the

tuberosity, look for the synovial bursa that separates them. It may have been removed by the dissector of the perineum.

Identify the sacro-tuberous ligament again. The gluteus maximus arises from it and conceals it ; but it can be felt through the muscle as a firm resisting band that stretches upwards and medially from the ischial tuberosity. Detach the gluteus maximus carefully from the ligament. As you do so, secure the perforating cutaneous nerve and the coccygeal branches of the inferior gluteal artery, which pierce the ligament. Divide the arteries in order to continue the reflexion of the muscle, but preserve the nerve. Continue the detachment of the muscle until the margins of the sacrum and coccyx are reached ; and, as they are approached, look for the plexus formed by the cutaneous branches of the sacral nerves.

The method of dissection suggested above is one best adapted to avoid injury to the branches of the inferior gluteal nerve ; and it gives a view of the structures subjacent to the muscle similar to that obtained by the surgeon operating on the proximal part of the sciatic nerve.

The method of dissection given in the early editions of this Manual was to reflect the muscle from its origin. That method also gives an excellent display of the subjacent structures, from a purely anatomical point of view, and the student who is dissecting the gluteal region for the second time might employ it with advantage.

Alternative Dissection.—Begin by defining the upper and lower borders of the muscle. Next, insinuate the left hand between the muscle and the deeper structures, on the medial side of the greater trochanter, either from above or from below according to the side on which the limb is being dissected. Then, when the muscle has been gently raised from the deeper structures, the reflexion should be commenced, but the plan to be adopted is different on the two sides.

On the left side, detach the muscle from its origins, beginning at the posterior part of the ilium. When the surface of the ilium from which it springs is cleared, the upper margin of the greater sciatic notch is reached. There, the dissector must proceed with caution, because the superior gluteal vessels emerge through the upper part of the notch, and their branches enter the deep surface of the gluteus maximus muscle. When these are secured, detach the muscle from the sacrum ; the piriformis muscle then comes into sight. Now, separate the gluteus maximus from the sacro-tuberous ligament and the coccyx. As this is being done, preserve the three sacral cutaneous nerves intact, in order that they may subsequently be traced to their origins ; but sever the coccygeal branches of the inferior gluteal artery which pierce the ligament and sink into the gluteus maximus. Preserve also the perforating cutaneous nerve, which pierces the sacro-tuberous ligament near the coccyx.

On the right side, commence the reflexion in the reverse manner. Raise the muscle from the ischial tuberosity and separate it first from the coccyx, then from the sacro-tuberous ligament and the sacrum, and finally from the ilium, preserving the nerves that pierce the sacro-tuberous ligament. When the muscle is detached from the ilium, secure the superior gluteal artery at the upper part of the greater sciatic foramen, and clean the branches which sink into the gluteus maximus.

When the muscle has been detached from its origin, pull it laterally, and divide the branches of the superior gluteal vessels that enter it. The *inferior gluteal vessels* and *nerve* come into view as they emerge at the lower border of the piriformis and sink into the gluteus maximus. Clean them. Then, sever the vessels, but cut the branches of the nerve out of the muscle leaving them attached to a small piece of flesh in order that they may be identified later.

Now, throw the whole muscle downwards and laterally, and examine its insertion.

When the reflexion of the muscle is completed note carefully the positions of the following parts: (1) the posterior border of the greater trochanter; (2) the gluteal tuberosity of the femur; (3) the tuberosity of the ischium; (4) the sacro-tuberous and sacro-spinous ligaments. Note also a group of muscles which descend from the tuberosity into the back of the thigh. They are the hamstring muscles; do not clean them at present.

The *trochanter major* is situated in the lower and lateral part of the area exposed. The *gluteal tuberosity* is immediately below it, and receives the lower deep fibres of the gluteus maximus. The *ischial tuberosity* lies about three inches medial to the distal part of the trochanter major. Rotate the thigh laterally (*i.e.* move it so that its anterior surface is turned away from the median plane); the trochanter is then approximated to the tuberosity; and it recedes from the tuberosity when the thigh is rotated medially.

The *sacro-tuberous ligament* extends upwards and medially from the tuberosity of the ischium to the margins of the sacrum and coccyx, and to the posterior inferior and superior iliac spines. The inferior or medial border of the ligament forms the posterior boundary of the perineum, which has already been explored by the dissector of the Abdomen. Its upper or lateral margin forms the posterior boundary of two openings called the greater and lesser sciatic foramina, which are separated from each other by the sacro-spinous ligament. The *sacro-spinous ligament* extends medially from the spine of the ischium to the last piece of the sacrum and the first piece of the coccyx; its medial part is hidden under cover of the sacro-tuberous ligament; but its lateral part can be felt by the finger-tip placed about one inch above the upper border of the tuberosity of the ischium.

On the second day after the body is turned on its face the dissector must examine the muscles, vessels and nerves

which lie directly subjacent to the gluteus maximus, and also the structures situated in a deeper plane.

Before the work is commenced, obtain a pelvis with the ligaments *in situ*; note the connexions of the sacro-tuberous and sacro-spinous ligaments, and the position of the sciatic foramina.

The **greater sciatic foramen** is the upper of the two. It is bounded by the greater sciatic notch and by both the ligaments, and it transmits :—

The piriformis muscle, which almost fills the foramen.
The superior gluteal vessels and nerve, above the piriformis.
The sciatic nerve
The nerve to quadratus femoris
The posterior cutaneous nerve of the thigh
The inferior gluteal vessels and nerve
The nerve to obturator internus
The internal pudendal vessels
The pudendal nerve
} below the piriformis.

The **lesser sciatic foramen** is bounded by the lesser sciatic notch and by both the ligaments, and it transmits :—

The tendon of the obturator internus.
The internal pudendal vessels.
The pudendal nerve.
The nerve to obturator internus.

All the structures mentioned, as well as other muscles, vessels, and nerves, have to be cleaned and examined. Therefore the second day's dissection is extensive and complicated, and unless it is proceeded with in a regular and definite manner it will not be successfully completed.

Dissection. Commence with the *superficial branches of the superior gluteal artery*, which enter the upper part of the gluteus maximus; follow them to the point where they emerge through the cleft between the gluteus medius and the upper border of the piriformis muscle. Clean the *piriformis*, from the great sciatic foramen to the greater trochanter. Then, clean the *posterior cutaneous nerve of the thigh*, following it upward to the lower border of the piriformis. Secure its perineal branch, which passes below the ischial tuberosity towards the perineum.

Follow the *inferior gluteal vessels* and *nerve* to the lower border of the piriformis.

Flex the knee, and keep it flexed by supporting the leg on a large block. That relaxes the hamstring muscles and the *sciatic nerve*, which is the next structure to be cleaned. It is the thick, firm, white cord that lies deep to the posterior cutaneous nerve. Cut its fascial covering at the level of the top of the greater trochanter. Insert the handle of the knife, and run it upwards, along the *lateral border* of the nerve, to the lower border of the piriformis, and downwards as far as possible. Clean the fascia from

the back of the nerve, and secure the branches to the hamstring muscles. Follow them to the muscles, and preserve the branches of the medial circumflex femoral artery which join them near their terminations.

Next, pull the upper part of the sciatic nerve laterally ; look

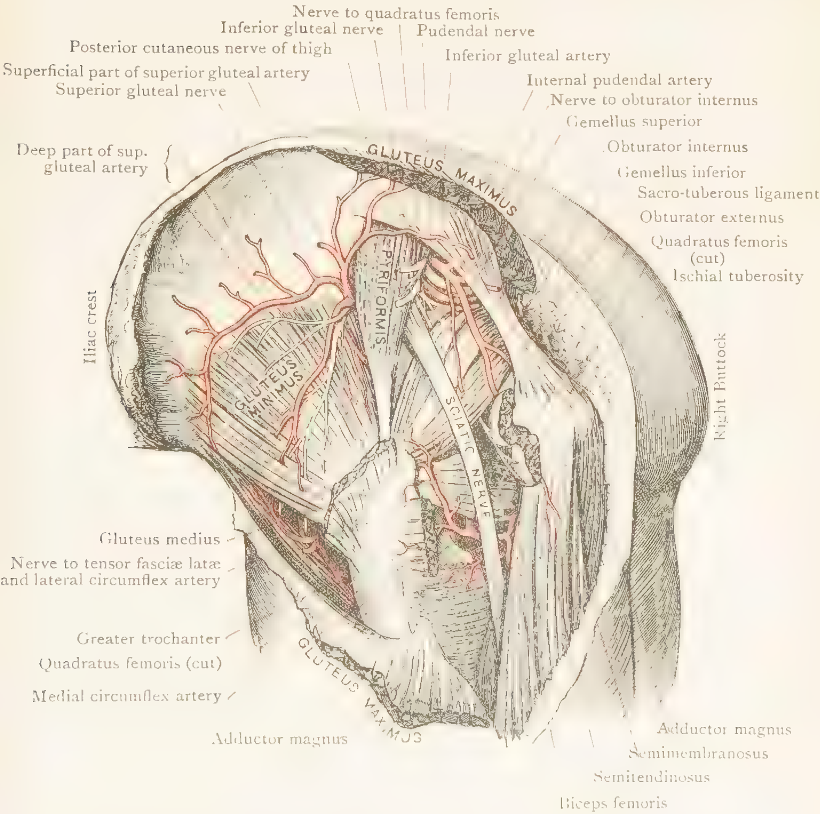


FIG. 116.—Dissection of the Gluteal Region of the Left Side. The Gluteus Maximus and the Gluteus Medius have been removed, and the Quadratus Femoris has been reflected.

for a slender nerve—the *nerve to the quadratus femoris* and trace it downwards till it disappears in front of a slip of muscle called the superior gemellus. About a finger's breadth medial to the sciatic nerve, look for the *nerve to the obturator internus*, the *internal pudendal vessels* and the *pudendal nerve*. Clean and preserve the artery and the nerves, but remove the veins.

Now, proceed to clean and examine the muscles that lie anterior to (*i.e.* deep to) the sciatic nerve. First, the *tendon of the obturator internus* passing from the lesser sciatic foramen to the greater trochanter, with a fleshy slip along each border the *superior* and *inferior gemellus*; below that, the quadrilateral sheet – *quadratus femoris* extending from the ischial tuberosity to the back of the greater trochanter; and, below the quadratus, the upper border of the *adductor magnus*. Clean the *transverse branch of the medial circumflex artery*, which emerges between the quadratus and adductor magnus; and look for a small artery, called the *first perforating*, as it pierces the adductor magnus at the medial border of the gluteal tuberosity.

After the muscles are cleaned, divide the tendon of the obturator internus about a finger's breadth from the lesser sciatic notch. Raise the medial part of the tendon, turn it backwards to find the bursa between it and the floor of the notch; note the subdivided character of the deep surface of the tendon.

Turn next to the hamstring muscles, which spring from the tuberosity of the ischium; separate the common tendon of the biceps femoris and the semitendinosus from the flattened tendon of the semimembranosus, which lies immediately subjacent. Then pull the hamstrings laterally and display the origin of the adductor magnus from the tuberosity.

Parts under Cover of the Gluteus Maximus. Four groups of structures lie under cover of the gluteus maximus, viz., bursæ, muscles, vessels and nerves.

The **bursæ** have been examined already (see p. 256): —

One overlies the origins of the *hamstrings* from the ischial tuberosity.
One overlies the lateral surface of the greater trochanter.
One overlies the upper part of the *vastus lateralis*

The **muscles** are :—

The posterior part of the *gluteus medius*.
The *piriformis*, issuing from the pelvis through the greater sciatic foramen.
The tendon of the *obturator internus*, issuing through the lesser sciatic foramen.
The *gemellus superior*, attached to the upper border of the obturator internus.
The *gemellus inferior*, attached to the lower border.
The *quadratus femoris*, extending transversely from the ischial tuberosity to the femur.
The upper part of the *adductor magnus*, immediately below the quadratus.
The *hamstring muscles*—*i.e.* the biceps femoris, semitendinosus, and semimembranosus—springing from the ischial tuberosity.
The upper part of the *vastus lateralis*, below the lateral surface of the greater trochanter.

The **vessels** and **nerves** also are numerous; they are :—

The *superficial branch* (or branches) *of the superior gluteal artery* appears between gluteus medius and piriformis. If these muscles are separated, the trunk of the superior gluteal artery will be seen, and, alongside it, the *superior gluteal nerve*.
The *sciatic nerve*, appearing below the piriformis.

The *nerve to quadratus femoris* is deep to (anterior to) the sciatic nerve.
The *posterior cutaneous nerve* is close by the medial side of the sciatic nerve, or on the back of it.
The *inferior gluteal vessels* and *nerve* are near the posterior cutaneous nerve.
The *nerve to obturator internus* appears below piriformis about a finger's breadth medial to the sciatic nerve.
The *internal pudendal vessels* are placed a little more medially.
The *pudendal nerve* is the most medial of the structures that emerge from the pelvis below piriformis.
The *ascending terminal branch* of the *medial circumflex artery* is seen between the inferior gemellus and the quadratus femoris; the *transverse terminal branch* appears at the lower border of the quadratus, and passes backwards to the hamstrings.
The *first perforating branch* of the profunda artery pierces the adductor magnus close to the lower part of the gluteal tuberosity.

Inferior Gluteal Nerve and Vessels.—The **inferior gluteal nerve** is the nerve of supply to the gluteus maximus. It springs from the sacral plexus, and enters the gluteal region through the lower part of the greater sciatic foramen. When the gluteus maximus was reflected, the nerve was seen breaking up into numerous twigs which entered the deep surface of the muscle.

The **inferior gluteal artery,** a branch of the internal iliac (hypogastric) artery, issues from the pelvis, with the nerve, and descends with the sciatic nerve. At the lower border of the gluteus maximus it is continued, as a fine cutaneous twig, to the back of the thigh, in company with the posterior cutaneous nerve.

Its branches are:—

1. Large *muscular* branches.
2. Cutaneous branches to the buttock and the back of the thigh.
3. The *coccygeal branch*, which runs medially, passes through the sacro-tuberous ligament, or between it and the sacro-spinous, and ends in branches for gluteus maximus and the skin over the coccyx.
4. The *companion artery of the sciatic nerve*—a very slender artery that accompanies the nerve for some distance, and then sinks into its substance.

Posterior Cutaneous Nerve of the Thigh.—This long, slender nerve arises, within the pelvis, from the sacral plexus. After escaping through the greater sciatic foramen, it descends on the back of the sciatic nerve or along its medial side, under cover of the gluteus maximus. From the lower border of the gluteus maximus it runs downwards, in the back of the thigh, immediately subjacent to the deep fascia. It will afterwards be traced to the skin of the calf of the leg.

In the gluteal region it gives off several branches, viz. :—

1. *Gluteal branches*, which wind round the lower border of the gluteus maximus to supply a limited area of the skin of the buttock.
2. A few twigs to the skin to the medial side of the thigh.

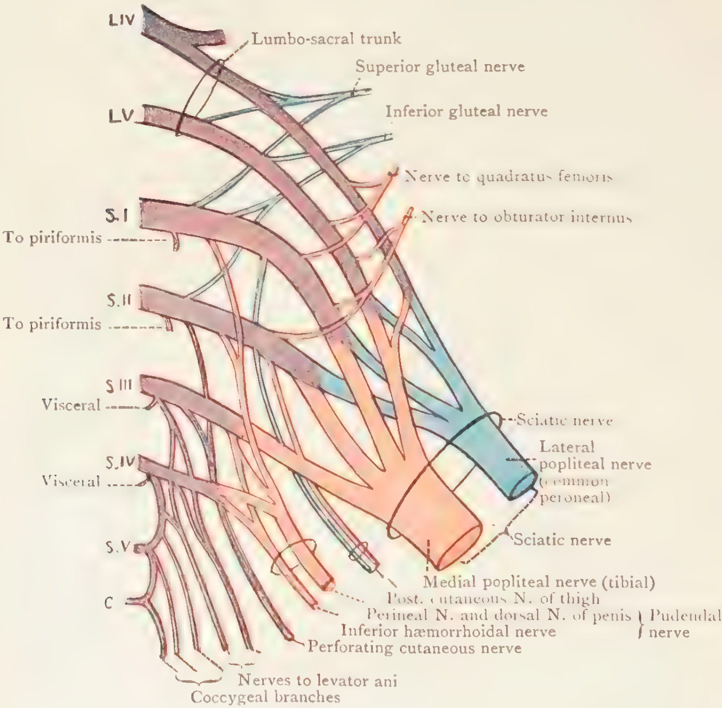


FIG. 117.—Diagram of Sacral Plexus.

3. The *perineal branch*, which turns medially, round the origin of the hamstring muscles, to reach the perineum.

Sciatic Nerve.—The sciatic nerve—the thickest nerve in the body—is a terminal branch of the sacral plexus, and enters the gluteal region through the lower part of the great sciatic foramen. At first it has the form of a flattened band, but soon it becomes oval or round.

The sciatic nerve traverses the gluteal region in the

interval between the greater trochanter of the femur and the tuberosity of the ischium, enclosed in a sheath of fascia ; it descends into the thigh to end half-way down the back of the thigh by dividing into two large branches called the *lateral* and *medial popliteal nerves* (common peroneal and tibial). In the gluteal region, it is under cover of the gluteus maximus, and lies, from above downwards, on (1) the ischium and the nerve to the quadratus femoris, (2) the tendon of the obturator internus with the two gemelli muscles, (3) the quadratus femoris. As it enters the thigh, it lies on the adductor magnus. The nerves to one or more of the hamstring muscles issue from the medial side of the main trunk at the level of the ischial tuberosity, or a little lower down.

The sciatic nerve sometimes splits into the lateral and medial popliteal nerves before it leaves the pelvis ; in which case, the medial popliteal nerve emerges from the pelvis below the piriformis, while the lateral nerve pierces the muscle.

Internal Pudendal Artery, Pudendal Nerve and **Nerve to the Obturator Internus.**—These structures are exposed, in the present dissection, in a very short part of their extent. They emerge from the pelvis through the greater sciatic foramen and cross the spine of the ischium and the sacro-spinous ligament ; they then enter the lesser sciatic foramen and pass out of view. The *nerve to the obturator internus* is placed most laterally. It lies on the base of the ischial spine, and furnishes a twig to the gemellus superior. The *internal pudendal artery*, with a companion vein on each side, crosses the tip of the spine. The *pudendal nerve* is placed most medially, and lies on the sacro-spinous ligament, close to the ischial spine. In some cases, however, the pudendal nerve unites in a plexiform manner with the nerve to the obturator internus, so that the whole, or a part, of it may lie lateral to the pudendal vessels.

Small Lateral Rotator Muscles of the Thigh.—Under this heading are included the piriformis, the obturator internus, and the two gemelli, the quadratus femoris, and the obturator externus. They all lie directly under cover of the gluteus maximus in the greater part of their extent, except the obturator externus, which lies deep (anterior) to the quadratus femoris, and cannot be properly seen from behind until that muscle has been reflected ; they are all inserted into

the greater trochanter, and they are related to the back of the hip joint. The first five are lateral rotators of the thigh when it is extended, but they become abductors when it is flexed. The obturator externus is a lateral rotator in both positions.

The **piriformis** arises chiefly, within the pelvis, from the middle three pieces of the sacrum. After it has passed through the greater sciatic foramen, its fleshy belly rapidly tapers and it ends in a rounded tendon which crosses superficial to the common tendon of the obturator internus and gemelli, and is inserted into the upper border of the greater trochanter (Fig. 111, p. 245). It is closely adherent to the subjacent obturator tendon for some distance. The piriformis is supplied by branches from the *first* and *second sacral nerves*.

The **obturator internus** muscle has a large, fan-shaped fleshy belly which arises, within the pelvis, from the side wall and front wall of the pelvic cavity. Its fibres converge on the *tendon*, which issues through the lesser sciatic foramen, bends at a right angle, and runs laterally across the back of the hip joint to be inserted into the medial surface of the greater trochanter (Figs. 111, 132). The deep surface of the tendon is divided into four or five portions by longitudinal grooves, and is separated by a *bursa* from the correspondingly ridged floor of the lesser sciatic notch (Fig. 116).

The *gemellus superior* arises from the upper margin of the lesser sciatic notch. Its fibres run along the upper border of the tendon of the obturator internus, and are inserted obliquely into it.

The *gemellus inferior* arises from the lower margin of the lesser sciatic notch, and is inserted into the lower border of the obturator tendon in a similar manner.

Close to their origins, the gemelli meet under cover of the obturator tendon, and form a fleshy bed on which the tendon lies; near the trochanter their fibres overlap the obturator tendon, and tend to cover its superficial surface.

The **quadratus femoris** lies between the gemellus inferior and the adductor magnus. It arises from the lateral border of the ischial tuberosity, and proceeds horizontally to gain insertion into the back of the greater trochanter and the adjoining part of the shaft of the femur (Fig. 132).

Dissection.—Secure the *nerve to the quadratus femoris*. Cut the gemelli at the lateral side of the nerve, and trace the

nerve downwards to the deep (anterior) surface of the quadratus femoris, and find its branches to the hip joint and gemellus inferior. Then, divide the quadratus femoris midway between its origin and insertion, throw the two parts aside, and clean the structures that are under cover of it—the lower part of the back of the *capsule of the hip joint*, the tendon of *obturator externus*, the *medial circumflex artery*, and the insertion of the *ilia-psoas* muscle.

The *nerve to the quadratus femoris* arises from the sacral plexus, escapes from the pelvis through the lower part of the greater sciatic foramen, in front of the sciatic nerve; descends over the ischium and the capsule of the hip joint, under cover of the sciatic nerve, the obturator internus and the gemelli; gives a twig to the hip joint, supplies the inferior gemellus, and sinks into the deep surface of the quadratus femoris to supply it.

The **obturator externus** muscle arises from the front of the pelvis, and its origin will be examined when the medial side of the thigh is dissected. It winds backwards below the hip joint, and its tendon is seen here passing obliquely upwards and laterally on the back of the neck of the femur to be inserted into the trochanteric fossa.

Medial Circumflex Artery.—This artery arises from the profunda in the femoral triangle. It passes backwards among the muscles of the medial side of the thigh, and ends near the upper border of the adductor magnus by dividing into ascending and transverse branches.

The *ascending branch* runs obliquely upwards and laterally, under cover of the quadratus femoris, on the posterior surface of the obturator externus, towards the trochanteric fossa, giving off muscular twigs. The *transverse branch* passes backwards, between the quadratus femoris and the adductor magnus, and enters the hamstring muscles. It anastomoses with the terminal twig of the transverse branch of the lateral circumflex artery, which, in a well-injected subject, will be noticed appearing from amidst the fibres of the upper part of the vastus lateralis. An arterial circle is thus formed around the upper part of the femur; it communicates proximally with the inferior gluteal artery and distally with the first perforating artery. This series of inosculations is sometimes spoken of as the *crucial anastomosis* of the thigh.

The dissector has now examined all the structures which lie below the level of the piriformis in the gluteal region. He should, in the next place, turn his attention to that portion of the dissection which lies above the level of that muscle. There, he will find several structures which lie in close relation to the ilium. These are the gluteus medius and minimus, and the tensor fasciæ latæ, together with the blood-vessels and nerve which supply them, viz., the superior gluteal vessels and nerve.

The posterior part of the gluteus medius was covered by the gluteus maximus; its anterior border is overlapped by the tensor fasciæ latæ; the rest of it is invested by the dense fascial layer already referred to, and is the fleshy substance felt through the skin and fasciae below the iliac crest on the side of the hip in the living body.

Dissection.—Remove the fascia from the superficial surface of the gluteus medius and pull the tensor fasciæ latæ forward.

Gluteus Medius.—This wide, thick muscle arises from the large area between the middle gluteal line and the iliac crest (Fig. 115, p. 256). The fibres converge to form a flattened band, partly fleshy and partly tendinous, which is inserted into the postero-superior angle of the greater trochanter and the oblique ridge on its lateral surface. A small *bursa* separates the tendon from the anterior part of the lateral surface of the trochanter.

The gluteus medius muscle is supplied by the *superior gluteal nerve*. As a whole, the muscle is an abductor of the thigh, but its anterior fibres can rotate the thigh medially, and the posterior fibres can rotate it laterally.

Dissection.—The gluteus medius must now be reflected. Keep the tensor fasciæ pulled well forward. Insert the fingers between the posterior borders of the gluteus medius and minimus, and separate the muscles, from behind forwards, to their anterior margins. Then divide the medius two inches above the trochanter major, and reflect the two parts towards their attachments. As the lower part of the muscle is reflected, look for the small bursa that lies between it and the trochanter. When the upper part of the muscle is raised, the branches of the superior gluteal vessels and nerve, will be exposed; clean them and preserve them, except the twigs which enter the gluteus medius and interfere with its reflexion. As you follow the branches of the artery and nerve, clean the surface of the gluteus minimus.

Superior Gluteal Nerve and Vessels.—The **superior gluteal nerve** arises from the sacral plexus, and escapes from the pelvis through the upper part of the greater sciatic foramen, above the piriformis. It then turns forward, between the gluteus medius and minimus, and immediately divides into an upper and a lower branch. The upper branch follows the upper border of the gluteus minimus close to the middle gluteal line of the ilium, and it gives branches to the gluteus medius. The lower branch of the nerve crosses the middle of the gluteus minimus. It supplies

branches to both the gluteus medius and minimus; and then passes between their anterior borders to end in the tensor fasciæ latæ.

The **superior gluteal artery** is a large vessel which springs from the internal iliac (hypogastric) artery and escapes from the pelvis with the nerve and vein; immediately after its exit, it divides into a superficial and a deep division.

The *superficial division* has been already seen during the reflexion of the gluteus maximus. Its branches are distributed to the deep surface of that muscle.

The *deep division* bifurcates, close to its origin, into a superior and an inferior branch which accompany the two branches of the nerve.

Gluteus Minimus.—This also is a thick, wide muscle; it arises from the broad area of the ilium which is included between the middle and inferior gluteal lines (Fig. 115, p. 256). The muscular fibres pass gradually into an aponeurotic tendon which covers the superficial surface of the distal part of the muscle. The tendon narrows into a flattened band, which is inserted into a special impression on the lower and lateral part of the front of the greater trochanter (Fig. 111, p. 245). It is intimately connected, near its insertion, with the capsule of the hip joint; and it is separated from the upper and anterior part of the trochanter major by a small bursa.

The gluteus minimus is supplied by the *superior gluteal nerve*. Its actions are the same as those of the gluteus medius.

> ***Dissection.***—Detach the gluteus minimus from its origin and turn it downwards, separating it from the capsule of the hip joint. Open the bursa, and examine its extent.

Parts under Cover of the Gluteus Minimus.—As the gluteus minimus is reflected three structures are displayed:—(1) part of the capsule of the hip joint; (2) the reflected tendon of the rectus femoris; and (3) the bursa between the gluteus minimus and the greater trochanter.

The upper part and the posterior part of the **capsule of the hip joint** are now exposed, and should be examined. The capsule is loosely attached to the back and upper part of the neck of the femur, about a finger's breadth medial to the trochanter, but firmly attached to the acetabular rim. Many of the fibres of the posterior part of the capsule run circularly

around the neck of the femur and are named the *zona orbicularis*. Others run parallel with the neck, at right angles to the circular fibres; and in the lower part of the capsule, which is overlapped by the obturator externus, there is a band of fibres, called the *ischio-femoral ligament*, which runs upwards and laterally parallel with the obturator externus.

The **reflected tendon of the rectus femoris** is attached to the floor of a groove situated immediately above the margin of the acetabulum, and is there embedded under the superficial fibres of the capsule. To expose it, cut through these fibres parallel with the direction of the tendon.

POPLITEAL FOSSA

The dissection of the popliteal fossa should be carried out before the back of the thigh is disturbed, in order that its contents may be examined before the medial and lateral boundaries of its upper portion are displaced. The dissection should therefore begin on the third day after the body has been turned.

The following structures will be met with :—

1. Superficial fascia.
2. The short saphenous vein.
3. The posterior cutaneous nerve of the thigh.
4. Popliteal fascia.
5. Muscles which bound the fossa. { Biceps femoris. Semitendinosus. Semimembranosus. Gastrocnemius. Plantaris.
6. The lateral and medial popliteal nerves and their branches.
7. The popliteal artery and vein and their branches and tributaries.
8. A few lymph glands.
9. A slender branch from the obturator nerve.
10. The popliteus muscle, in the floor of the fossa.

Surface Anatomy. The region of the popliteal fossa is behind the knee, opposite the lower third of the femur, the knee joint and the upper sixth of the tibia. It appears as a hollow when the knee joint is flexed, but it bulges slightly when the joint is fully extended. The bony points and the tendons in this region are identified more easily in the living body than in the dead.

In the sides of the area, about the middle of its length, the **condyles of the femur** are easily distinguished, and, below

them, the **condyles of the tibia.** But the best landmark in this region is the **head of the fibula.** It is below the posterior part of the lateral condyle of the tibia, and forms a well-marked prominence far back on the lateral side of the limb, at the same level as the tubercle of the tibia.

The thick cord that descends to the head of the fibula is the tendon of insertion of the **biceps femoris,** which is most easily identified when the joint is flexed. Having identified it, examine it with the knee alternately extended and flexed. When the knee is straight, the tendon lies on the posterior part of the lateral surface of the lateral condyle of the femur, and produces a slight, longitudinal elevation, far back on the lateral side of the knee. Place your finger on the back of the knee, just medial to that elevation, and press : the bone felt is the back of the lateral condyle. Move your finger to and fro sideways : the large nerve felt is the **lateral popliteal.** Flex the knee slowly and watch the tendon of the biceps : it slips off the lateral condyle and comes more fully into the lateral boundary of the popliteal fossa ; and it is now much more easily seen than when the knee was straight, for the tendon now forms a ridge, on the lateral side of the limb, bounded anteriorly by a distinct groove. In a thin limb, the anterior boundary of that groove is another ridge, so well marked that it is sometimes mistaken for the ridge made by the tendon of the biceps. It is produced by the strong, posterior part of the **ilio-tibial tract,** and can be traced down to a small tubercle on the front of the lateral condyle of the tibia. With the knee still flexed, press your finger into the interval between the head of the fibula and the femoral condyle to feel the rounded, cord-like **lateral ligament of the knee joint.** Then, place your finger on the back of the head of the fibula, push the soft parts medially, and move the finger sideways to feel the **lateral popliteal nerve** again.

On the medial side also, the tendons are palpated more easily when the knee is flexed. The **semitendinosus** is felt near the surface, posteriorly ; and the **gracilis** is felt medially, but is obscured to some extent by the fleshy **sartorius,** which lies just in front of it, and even overlaps it. The **semimembranosus** tendon, thicker than either the gracilis or the semitendinosus, is deep to both of them, but can be felt if firm pressure is used.

In the upper part of the popliteal region, the muscles of the

two sides are fairly close together ; and the distal part of the thick, fleshy belly of the semimembranosus makes a periodic bulging near the middle line of the limb, as the muscle contracts and relaxes when a person is walking. In the middle of the region, the pulsations of the **popliteal artery** are felt when deep pressure is made. In the lower part, the two heads of the **gastrocnemius** muscle form two rounded cushions that merge inferiorly into the calf.

Above the popliteal region, the back of the thigh is smooth and rounded ; but, in a thin person, the outlines of the bellies of the hamstring muscles may be seen faintly.

> ***Dissection.***—Reflexion of the Skin.—Place a block under the knee to support the limb and to make the boundaries of the popliteal fossa tense. *Incisions*—(1) A vertical incision along the middle line of the limb in the lower third of the thigh and upper fourth of the leg. (2) Transverse incisions at the ends of the vertical incision, each extending halfway round the limb (21, 22 of Fig. 113). Separate the two flaps of skin from the superficial fascia and turn them to their respective sides.

Superficial Fascia and its Contents.—The superficial fascia of the popliteal region presents no peculiar features, and, as a rule, it contains only a moderate amount of fat, amidst which the following structures must be sought :—

1. Proximal part of short saphenous vein.
2. Branches and termination of posterior cutaneous nerve of thigh.
3. Posterior branch of medial cutaneous nerve of thigh.
4. Sural communicating branch of lateral popliteal nerve.

> ***Dissection.***—Look first for the *short saphenous vein* ascending from the calf and piercing the deep fascia over the distal part of the fossa. As the upper part of the vein is being cleaned, secure the terminal part of the *posterior cutaneous nerve of the thigh*, which runs alongside the vein. At a higher level, in the middle line of the popliteal area, one or more twigs from the posterior cutaneous nerve may be found piercing the deep fascia.
>
> The posterior branch of the *medial cutaneous nerve* of the thigh has been found already, on the medial side of the thigh (Fig. 114). Follow it now, as it descends to the back of the calf. The *sural communicating nerve* may be found at the lower and lateral part of the popliteal area as it pierces the deep fascia (Fig. 114). Sometimes, however, the nerve pierces the deep fascia much lower down, and will not be found until the back of the leg is dissected. After the structures mentioned have been secured and cleaned, remove the remains of the superficial fascia, but avoid injury to the deep fascia.

Popliteal Fascia. The deep fascia of the popliteal region is thin, but it possesses considerable strength owing to the transverse fibres which are interwoven amidst its longi-

tudinal fibres. It is firmly attached, on each side, to the tendons of the muscles which bound the popliteal fossa.

Boundaries.—The popliteal fossa is diamond-shaped. It is bounded, above and laterally, by the *biceps femoris muscle* ; above and medially, by the *semitendinosus* and the *semimembranosus muscles*, supplemented by the *gracilis*, the *sartorius*, and the tendon of the *adductor magnus*—the semitendinosus lying on the back of the semimembranosus, while the other muscles are farther forward. The lower part of the fossa is bounded, on the lateral and medial sides, by the converging heads of the *gastrocnemius* (Fig. 118), supplemented, on the lateral side, by a small muscle called the *plantaris*, which lies along the medial border of the lateral head.

The dissector will now clean the upper boundaries of the fossa, leaving the lower boundaries to be cleaned at the same time as the contents.

Dissection.—Clean first the upper lateral boundary. Make an incision through the deep fascia along its medial margin ; turn the fascia laterally and expose the *biceps femoris*. Clean the muscle and its tendon. Turn next to the upper medial border of the space. Make an incision through the deep fascia along its lateral margin, and reflect the fascia towards the medial side to expose the *semitendinosus* tendon and *semimembranosus* muscle. Follow the tendon of the semitendinosus to the level of the medial condyle of the tibia ; then pull it aside and clean the distal part of the semimembranosus and its tendon. Pull the part of the muscle which lies at the level of the medial condyle of the femur towards the medial side of the knee and display the *semimembranosus bursa*, which lies between the semimembranosus and the medial head of the gastrocnemius. Open the bursa and find whether it communicates with the bursa in front of the gastrocnemius, and whether that bursa communicates with the cavity of the knee joint.

Now pull the semitendinosus and semimembranosus laterally, and clean the *gracilis*. The *saphenous nerve* emerges between the gracilis and the sartorius, accompanied by an artery ; secure the artery and nerve and follow them downwards with the long saphenous vein. Then pull the gracilis medially and clean the distal part of the adductor magnus.

Before the dissector begins to open up the fossa, he should read the following paragraphs, which deal in a general way with the contents of the fossa.

Contents of the Fossa.—The principal objects in the popliteal fossa are the *lateral* and *medial popliteal nerves* and the *popliteal artery* and *vein*, with their branches and tributaries ; but the most superficial structure, in the upper part of the space, is the *posterior cutaneous nerve of the thigh*, which runs along the middle line, immediately subjacent to

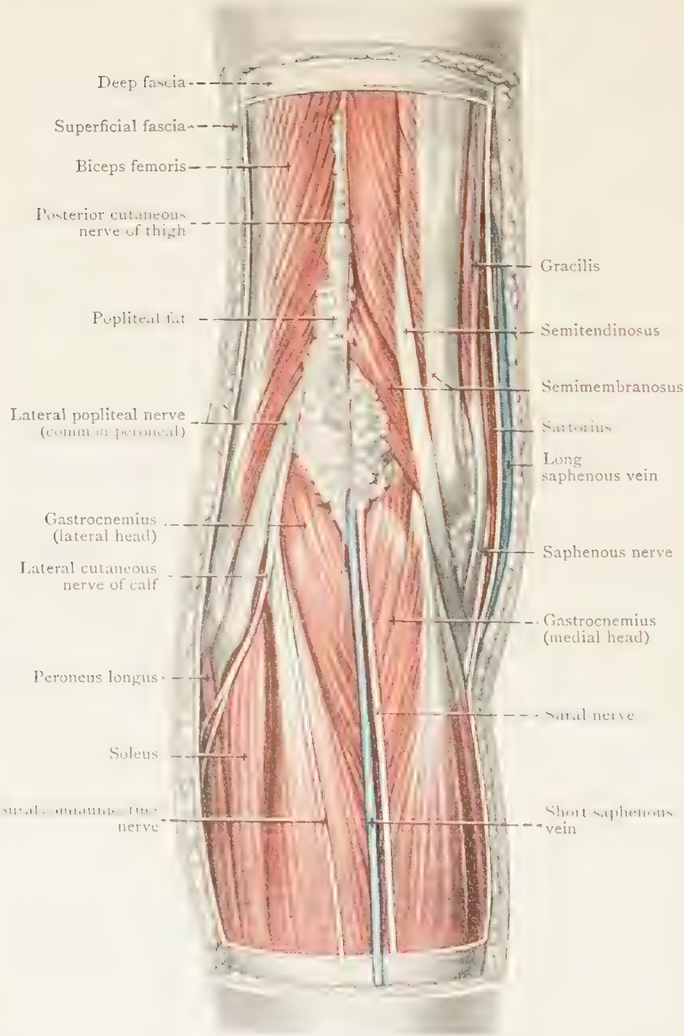


FIG. 118.—The Left Popliteal Region after removal of the Deep Fascia—the Muscles and Fat being left undisturbed.

the popliteal fascia, until it pierces that fascia in the lower part of the space.

The medial popliteal nerve is separated from the posterior

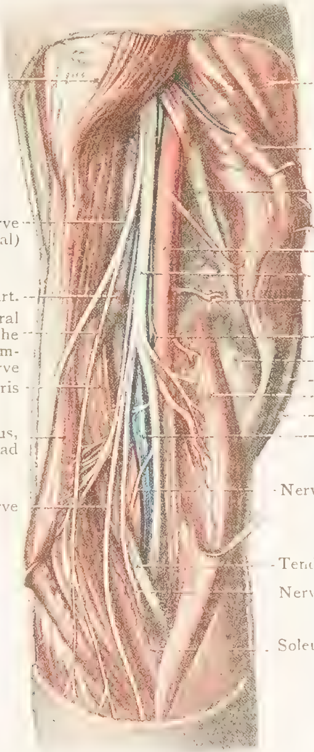


FIG. 119.—Dissection of the Left Popliteal Fossa. The upper boundaries have been pulled apart and the aponeurosis to which the two heads of the gastrocnemius are attached has been split and the heads displaced to their respective sides.

cutaneous nerve of the thigh by a thin layer of fat, and lies superficial to the popliteal vessels, which are situated in a much deeper plane, in close contact with each other. The lateral popliteal nerve lies along the upper lateral boundary of the fossa. Both the popliteal nerves give off branches, most of which are easily found, but their articular twigs are

delicate and are easily destroyed by the dissector who does not exercise care. One of the articular nerves, however, is derived not from a popliteal nerve but from the posterior division of the obturator nerve. It is a slender filament that descends in close apposition to the popliteal artery. Other important contents of the fossa are lymph glands, some of which lie relatively superficial, near the point where the short saphenous vein pierces the popliteal fascia, but the majority are deeply placed alongside the popliteal vessels.

The dissector will now open up the fossa and display its contents.

Dissection. Secure the *posterior cutaneous nerve of the thigh* at the point where it pierces the popliteal fascia, and follow it to the upper angle of the fossa ; then, remove the remains of the popliteal fascia from the upper part of the popliteal area.

Now, pull the posterior cutaneous nerve aside with a hook, and cut through the fat in the upper angle of the fossa till a large nerve—the *medial popliteal*—is exposed. Follow the nerve downwards, cleaning it, partly with the aid of the handle of the scalpel and partly by occasional touches with the point of the scalpel, and secure its cutaneous, muscular, and articular branches. Its cutaneous branch—the *sural nerve*—descends between the two heads of the gastrocnemius. Follow that branch to the distal angle of the fossa. The articular branches are three in number—*superior medial genicular*, *inferior medial genicular*, and *middle genicular*. The superior branch arises at or above the upper angle of the fossa, and the other two at lower levels. Follow them as far as possible. The *muscular branches* arise about the middle of the fossa and pass to the two heads of the gastrocnemius, the plantaris, the soleus, and the popliteus. Separate the heads of the gastrocnemius and trace these branches to the muscles—except the nerve to the popliteus which lies deeply and will be followed in a subsequent dissection.

Return to the upper angle of the fossa, and secure the *lateral popliteal* nerve. Follow it to the lateral angle, and, thence, to the back of the head of the fibula, avoiding injury to its branches. Look for its *genicular* branches. They arise high up in the fossa or above the fossa ; the upper one passes out of the fossa above the lateral femoral condyle ; the lower one accompanies the nerve trunk out of the fossa. Secure the *sural communicating* branch and the *lateral cutaneous nerve of the calf*. They arise from the lateral popliteal near the lateral angle of the fossa (sometimes by a common stem). Follow them downwards.

Next, clean the plantaris and the two heads of the gastrocnemius, dividing the muscular arteries if they are in the way. Separate the plantaris from the lateral head, avoiding injury to the *nerve to the soleus*, which passes between them.

Now, clean the popliteal vessels and their branches and tributaries. Begin by pulling the tibial nerve laterally and clearing away the fat that lies superficial to the vessels. The popliteal vein is first encountered. Look in the groove between

the upper part of the artery and the vein for the *genicular branch of the obturator nerve.* It is a mere filament, and easily escapes notice. If you find it, trace it downwards to the back of the knee joint, and upwards into the substance of the adductor magnus.

Then, clean the *popliteal vein.* Not uncommonly, there are accessory venous channels that communicate with the main vein and anastomose with one another around the artery. If they are present, remove them; but be careful of the branches of the artery, and preserve the short saphenous vein.

Next, clean the *popliteal artery* and its branches. The

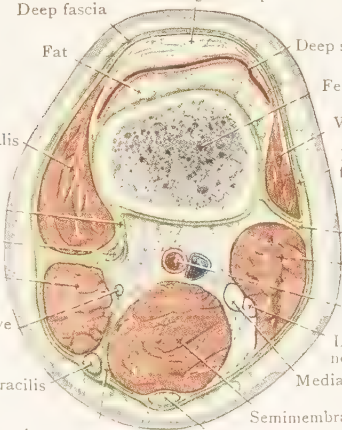


FIG. 120.—Transverse section through Proximal Part of Popliteal Region of Thigh.

muscular branches are met with first. Clean them and divide them. Now, scrape the fat away from the bottom of the fossa with the handle of the knife; but take care of the articular vessels and nerves. The articular or *genicular arteries* spring from the popliteal artery; they lie close to the floor of the fossa and are joined by the genicular nerves. They were seen, therefore, when the nerves were traced. Follow the two superior and inferior pairs out of the fossa, and the single, middle artery to the middle of the posterior ligament of the knee joint.

Floor of the Fossa.—The floor is formed from above downwards by—(1) the popliteal surface of the femur; (2) the capsule of the knee joint; and (3) the strong fascia which covers the popliteus muscle.

Popliteal Fossa seen in Section through the Frozen Knee.—The diamond-shaped space on the back of the knee joint which is

brought into view by dissection differs widely from the condition observed when transverse sections are made through this part of the frozen limb (Fig. 120). Before the skin and fasciæ are removed, all the parts are tightly braced together, and the popliteal fossa is represented merely by a small intermuscular interval between the distal parts of the hamstring muscles. The fossa in this condition is rather under an inch wide at its broadest part. The popliteal artery, therefore, is covered by muscles, except a very small part just above the knee joint.

Posterior Cutaneous Nerve of Thigh.—This nerve enters the popliteal fossa at its upper angle, and descends immediately subjacent to the deep fascia. It sends one or two twigs through the fascia to the skin, and finally pierces the fascia in the distal part of the fossa. Its terminal twigs are distributed to the skin over the proximal part of the calf of the leg.

Medial Popliteal Nerve (N. Tibialis).—The medial popliteal nerve is the larger of the two terminal branches of the sciatic nerve, and begins a little above the popliteal fossa—about the middle of the back of the thigh. It enters the fossa at its upper angle, emerging from under cover of the biceps femoris. It bisects the fossa and ends at its distal angle by changing its name to *posterior tibial nerve*.

Its superficial position in the fossa has already been referred to. When it enters the fossa, it lies on the lateral side of the popliteal vessels (Fig. 138); at the mid-length of the space, it crosses superficial to them; and in the distal part of the space, it is medial to them. Consequently, the muscular branches, given off in the lower part of the fossa for the lateral head of the gastrocnemius, the plantaris, the soleus, and the popliteus, cross behind the vessels to reach these muscles.

The branches of the nerve are classified as cutaneous, muscular, and articular.

The *sural nerve* is the cutaneous branch. It arises about the middle of the fossa, and runs downwards in the furrow between the two heads of the gastrocnemius into the back of the leg, and thence, along the lateral side of the foot, to the little toe (Fig. 114).

The *muscular branches* supply both heads of the gastrocnemius, the plantaris, the soleus, and the popliteus: they come off in the distal part of the fossa. The branch to the soleus passes between the plantaris and the lateral head of the gastrocnemius, and enters the superficial surface of the soleus near its upper end. The branch to the popliteus also

requires special notice. It arises lower down than the others, and, having crossed behind the popliteal artery, it descends over the popliteus muscle, and gains the anterior surface of

FIG. 121.—Popliteal Fossa. The two heads of the gastrocnemius and portions of the semimembranosus and semitendinosus have been removed.

the muscle by winding round its distal border. This will be seen better when the popliteus muscle is dissected.

The *articular branches* are three in number. They are given off in the upper part of the fossa—sometimes even above the fossa. They accompany the middle genicular artery and the two medial genicular arteries, and supply the ligaments and synovial membrane of the knee joint.

The *superior medial genicular nerve* runs medially, above the medial condyle of the femur, and under cover of the semitendinous, semimembranosus, and the tendon of the adductor magnus.

The *middle genicular nerve* pierces the middle of the posterior ligament of the knee joint to supply the cruciate ligaments in the interior.

The *inferior medial genicular nerve* is larger than the other two, and more easily found. It runs downwards and medially along the upper border of the popliteus muscle, under cover of the medial head of the gastrocnemius, and then curves forwards below the medial condyle of the tibia, under cover of the medial ligament of the knee and the tendons that overlie that ligament—sartorius, gracilis and semitendinosus.

Lateral Popliteal Nerve (N. Peronæus Communis).—The lateral popliteal nerve is the smaller of the two terminal branches of the sciatic nerve. It arises about the middle of the thigh, and terminates at the lateral side of the neck of the fibula, under cover of a muscle called the peroneus longus, by dividing into two branches named the *musculo-cutaneous nerve* and the *anterior tibial nerve*. It does not traverse the entire length of the popliteal fossa. It runs downwards and laterally along the medial border of the biceps femoris, and leaves the fossa at its lateral angle, where it crosses the plantaris and the lateral head of the gastrocnemius; it then passes behind the head of the fibula, from which it is separated by the upper part of the soleus; finally, it turns forwards to its termination between the lateral side of the neck of the fibula and the peroneus longus. In the fossa, it is covered only by skin and fasciæ, and, in the living limb, it can be rolled under the finger, where it lies on the gastrocnemius and on the soleus.

It gives off two cutaneous and three articular branches.

The *cutaneous branches* are the sural communicating nerve and the lateral cutaneous nerve of the calf. They frequently take origin by a common stem.

The *sural communicating nerve* arises in the upper part of the popliteal fossa, and runs downwards into the calf, and joins the sural nerve at a varying level.

The *lateral cutaneous nerve of the calf* arises as the lateral popliteal lies on the lateral head of the gastrocnemius. It pierces the deep fascia almost at once, and descends to

supply the skin of the lateral and anterior surfaces of the upper part of the leg.

The *articular branches* are the superior and inferior lateral genicular branches and the recurrent genicular nerve. The first two accompany the lateral genicular arteries. They are of small size, and it is difficult to find them.

The *superior lateral genicular nerve* arises above the fossa, descends into the fossa, and then runs laterally above the lateral condyle of the femoris, under cover of the lateral popliteal nerve and the biceps. The *inferior lateral genicular nerve* arises in common with or near the superior nerve. It descends with the lateral popliteal nerve to the lateral angle of the fossa, and then curves forwards below the lateral condyle of the femur, under cover of the lateral ligament of the knee and the tendon of the biceps. It is, therefore, at a higher level than the inferior medial nerve. The *recurrent genicular nerve* springs from the termination of the lateral popliteal nerve. It runs upwards to the front of the knee, and will be dissected at a later stage (p. 329).

Popliteal Artery (Figs. 121, 122).—The popliteal artery is the continuation of the femoral artery, and is therefore part of the great arterial trunk of the lower limb. It begins at the opening in the adductor magnus; and it descends to terminate at the distal border of the popliteus muscle by dividing into the anterior and posterior tibial arteries. The division is hidden from view at present by the upper border of the soleus muscle; but it will be exposed when the leg is dissected.

The artery is deeply placed. In the upper part of the fossa, it is under cover of the semimembranosus (Fig. 120). Between the condyles, it is covered by fat, and is crossed by the popliteal vein and the medial popliteal nerve. In the lower part of the fossa, it is overlapped by the heads of the gastrocnemius, and is crossed by the plantaris and by the nerves to the lateral head of the gastrocnemius, plantaris, soleus and popliteus. At its termination, it is under cover of the gastrocnemius and the upper border of the soleus.

Throughout its whole course, the popliteal artery rests against the floor of the popliteal fossa. In its proximal part, it is separated from the femur by some fat; between the condyles of the femur, it crosses the capsule of the knee joint; and, in the distal part of the fossa, it is in contact with the fascia of the popliteus muscle.

The popliteal vein lies in a more superficial plane, and crosses the artery. It is postero-lateral to the artery in the proximal part of the fossa, and on its medial side in the distal part. The two vessels, however, are in close association throughout, and are bound together by a dense fibrous sheath.

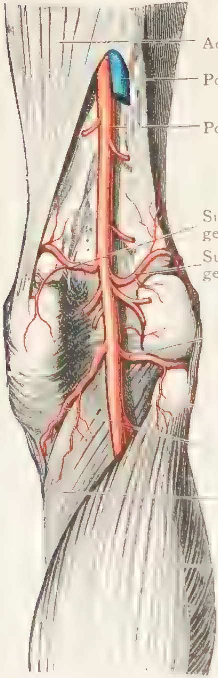


Fig. 122.—Right Popliteal Artery and its Branches.

The medial popliteal nerve is superficial to both vessels, and crosses them from the lateral to the medial side.

The *branches of the popliteal artery* are :—

1. Muscular. 2. Cutaneous. 3. Articular.

The *muscular branches* are distributed to the hamstring muscles and to the muscles of the calf of the leg.

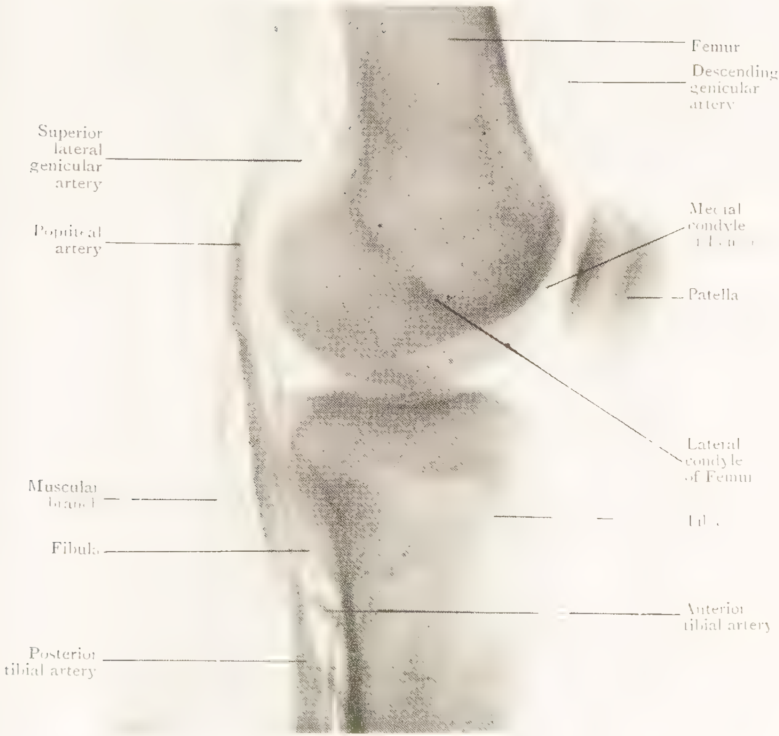
The *cutaneous branches* are irregular twigs that arise from the muscular branches ; the most constant of them accompanies the upper part of the sural nerve.

The *articular branches* are the five genicular arteries, viz., two superior, two inferior, and one middle. They are distinguishable from the muscular branches because they cling to the floor of the fossa, and accompany the nerves.

The two **superior genicular arteries** spring from the main trunk in the interval between the upper parts of the condyles of the femur. Inclining upwards, they meet the corresponding genicular nerves, and accompany them above the femoral condyles.

The two **inferior genicular arteries** arise opposite the knee joint. The *lateral* one runs laterally across the popliteus, under cover of the plantaris and lateral head of the gastrocnemius, and accompanies the lateral nerves between the femoral condyle and the head of the fibula.

PLATE XVII



[illegible] Lateral radiograph of the Knee of an injected Lower Limb.
(Major T. Rankine.)

PLATE XVIII

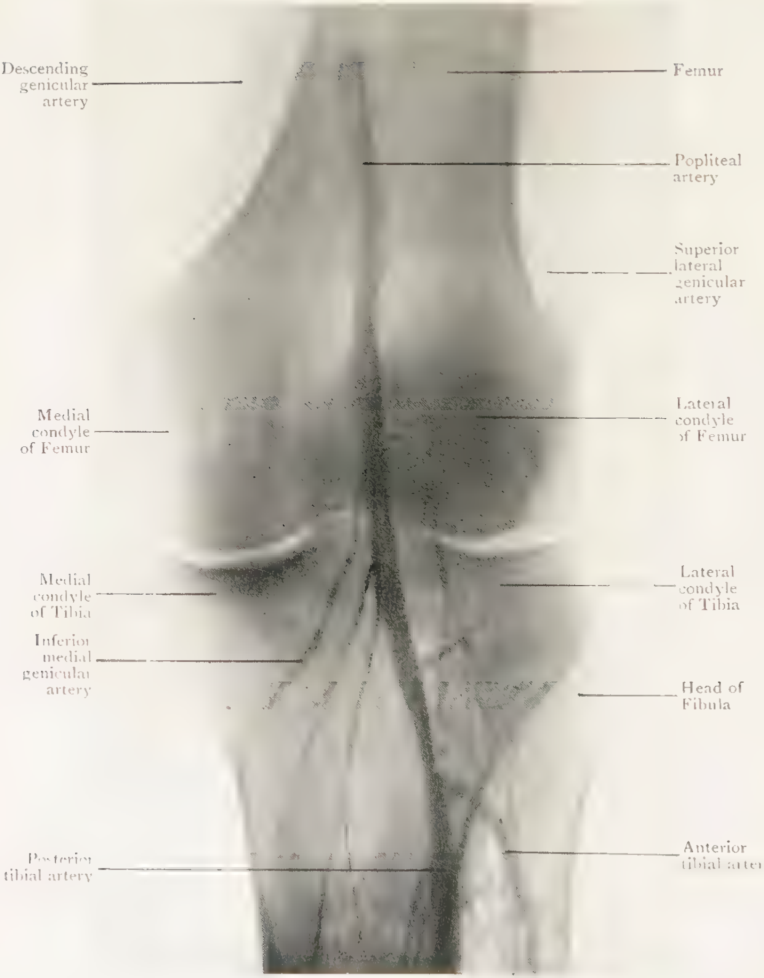


FIG. 124.—Antero-posterior radiograph of the Knee of an injected Lower Limb. (Major T. Rankine.)

The *medial* one runs obliquely, with the medial genicular nerve, along the upper border of the popliteus.

The **middle genicular artery** springs from the popliteal as it lies on the oblique posterior ligament of the knee joint. It pierces that ligament to reach the synovial membrane and the cruciate ligaments in the interior of the joint.

Genicular Branch of the Obturator Nerve.—This slender continuation of the posterior division of the obturator nerve usually lies on the posterior surface of the popliteal artery. It enters the popliteal fossa by piercing the distal fibres of the adductor magnus; and it enters the knee joint after passing through the oblique posterior ligament.

Popliteal Vein.—This vessel is formed, near the distal border of the popliteus muscle, by the union of the venæ comitantes of the anterior and posterior tibial arteries. It ascends through the popliteal fossa to the opening in the adductor magnus, where it becomes the femoral vein. The relations which it presents to the popliteal artery and the medial popliteal nerve have been detailed already. In addition to tributaries corresponding to branches of the artery, it receives the short saphenous vein. By slitting it open with the scissors the dissector will see that it possesses three (sometimes four) valves in its interior.

BACK OF THIGH

The dissection of the back of the thigh must be completed on the fifth day. The following are the structures which are to be displayed :—

Superficial fascia.
Cutaneous nerves.
Deep fascia.
Nerves, { Posterior cutaneous, of thigh. Sciatic.

Muscles, { Biceps femoris. Semitendinosus. Semimembranosus. Adductor magnus.
Arteries, Four perforating.

Dissection.—**Reflexion of Skin.**—Make a vertical incision through the middle of the belt of skin which still encircles the limb posteriorly, and reflect the two flaps.

Superficial Fascia and Cutaneous Nerves. The superficial fascia of the back of the thigh presents no features of special interest, but in it there ramify cutaneous nerves derived from three sources—(1) from the *posterior cutaneous nerve of the thigh*, (2) from the *lateral cutaneous nerve of the thigh*, and (3) from the *posterior branch of the medial cutaneous nerve.* In rare cases, there is also a *cutaneous branch* of the *obturator nerve* in the lower and medial part of the back of the thigh.

Dissection.—Look for the branches of the posterior cutaneous nerve of the thigh along the middle of the back of thigh ; they vary in number, and they pierce the deep fascia at varying levels (Fig. 114, p. 252). To facilitate the search for them, find the trunk of the nerve in the gluteal region, and pull gently on it.

Follow the branches of the lateral and medial cutaneous nerves from the portions of those nerves which were displayed when the front of the thigh was dissected.

Remove the remains of the superficial fascia to display the deep fascia.

Deep Fascia.—The deep fascia is thin but fairly strong. It consists of longitudinal fibres blended with transverse fibres.

Dissection.—Divide the deep fascia by a longitudinal incision along the middle of the back of the thigh, and be careful not to injure the *posterior cutaneous nerve of the thigh*, which lies immediately under cover of the fascia. Turn the two flaps of deep fascia aside, and then follow and clean the posterior cutaneous nerve.

Then, clean the posterior surfaces of the *hamstring muscles*. Having done so, find the *sciatic nerve* in the buttock. Follow it downwards, pushing the long head of the biceps medially ; trace its branches into the hamstring muscles and adductor magnus. At the same time, note the muscular arteries that run near the nerves ; they come from the *perforating branches* of the profunda artery.

Now, clean the *semitendinosus* and both heads of the *biceps* thoroughly from end to end (retaining their nerves) ; and, having pulled the semitendinosus and the long head of the biceps laterally, deal in like manner with the *semimembranosus*.

Flexor Muscles.—The flexor group of muscles are the biceps femoris, the semitendinosus and the semimembranosus, and they are supplied by the sciatic nerve. Their fleshy bellies compose the muscular mass on the back of the thigh ; and their tendons in the ham or popliteal region give them the colloquial name of the **hamstrings**.

The **biceps femoris** arises by two heads—a *long* and a *short*—and is inserted, chiefly, into the head of the fibula. The *long head* arises, by a tendon common to it and the semitendinosus (Fig. 115, p. 256), from the upper, medial part of the ischial tuberosity. Some fibres from the sacrotuberous ligament are continued into it. The *short head* arises from the linea aspera and the upper half of the lateral supracondylar ridge ; its fibres are parallel, and run downwards and laterally to join the anterior and medial surface of the tendon of insertion. This tendon descends across the lateral head of the gastrocnemius, and the lateral surface of the knee joint to reach its insertion into the head of the fibula.

Near the insertion, the tendon overlies the lateral ligament of the knee, which first grooves the tendon deeply and then splits its lower end into two unequal parts.

Each head of the biceps femoris receives its nerve supply from the sciatic nerve. The twigs to the long head are derived from the medial popliteal part of the nerve, and that to the short head from the lateral popliteal part. Both heads flex the knee joint and rotate the leg laterally. The long head is also an extensor of the hip joint.

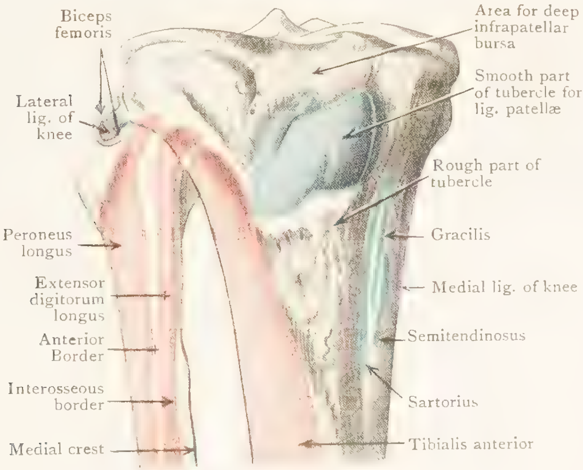


FIG. 125.—Anterior aspect of Proximal Portions of Bones of Leg with Attachments of Muscles mapped out.

The **semitendinosus** muscle arises, in common with the long head of the biceps, from the tuberosity of the ischium (Fig. 115, p. 256). The muscular belly ends, in the distal third of the thigh, in a long, cylindrical tendon which passes downwards on the semimembranosus muscle. At the medial side of the knee, the tendon bends forwards, crosses the medial ligament of the knee joint, and spreads out to be inserted chiefly into the upper part of the medial surface of the tibia, behind and below the gracilis. Near its insertion, it is partly adherent to the tendon of the gracilis, and both tendons are concealed by the expanded tendon of the sartorius. The

tibial intertendinous bursa separates them from the sartorius, and another separates the semitendinosus from the medial ligament of the knee; the two bursæ communicate so freely that they are, in fact, one bi-locular bursa.

The muscular belly of the semitendinosus is divided into upper and lower parts by a very oblique tendinous intersection, and each part receives a branch from the sciatic nerve. The muscle is a flexor of the knee, a medial rotator of the leg, and an extensor of the hip joint.

The **semimembranosus** muscle arises by a tendon from the upper lateral part of the tuberosity of the ischium (Fig. 115, p. 256). The tendon of origin is broad at its attachment to the bone, and narrows as it passes medially in front of the origin of the biceps femoris; it then expands again, and, passing downwards and medially, in front of the semitendinosus, is folded in such a manner as to form a groove in which the semitendinosus lies. The fleshy belly arises from this tendon, and, at the back of the knee, it becomes a thick flattened tendon which springs from the medial border and deep surface of the muscle; the tendon is inserted into the floor of the groove on the back of the medial condyle of the tibia, partly under cover of the medial ligament of the knee joint. It sends extensions also to the back of the capsule of the knee joint and to the fascia of the popliteus. The *semimembranosus bursa* lies between the tendon and the medial head of the gastrocnemius; it often curves round the medial side of the gastrocnemius to communicate with a bursa which lies between that head and the back of the knee joint.

The semimembranosus is supplied by the sciatic nerve. Its actions are the same as those of the semitendinosus.

Sciatic Nerve. The sciatic nerve emerges from the pelvis through the greater sciatic foramen, descends through the gluteal region and the back of the thigh, and ends, at a variable point above the popliteal fossa, by dividing into the lateral and medial popliteal nerves.

Its relations in the gluteal region have been considered already (p. 264), and should be studied again. In the back of the thigh, it lies on the posterior surface of the adductor magnus, under cover of the long head of the biceps.

The branches that spring from the trunk of the sciatic nerve supply the biceps, semitendinosus, semimembranosus and the ischial or posterior part of the adductor magnus.

Separate branches arise for the two heads of the biceps—the one to the short head from the part of the sciatic nerve that becomes the lateral popliteal nerve ; the one to the long head from the medial popliteal part. Two branches arise for the

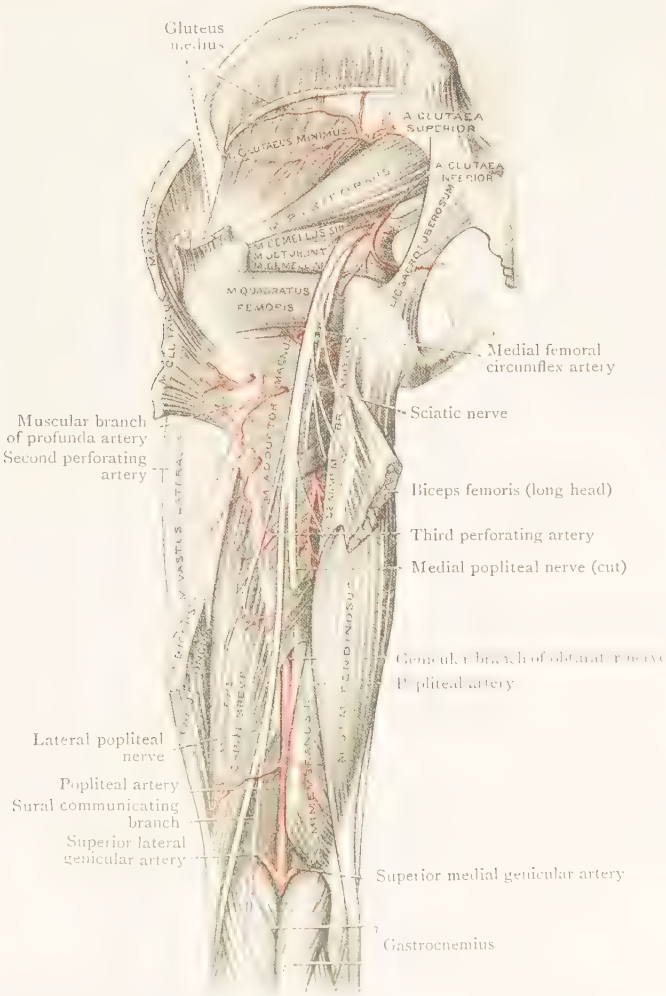


FIG. 126.—Dissection of the Gluteal Region and Back of Thigh.

semitendinosus—an upper and a lower. The branches for the semimembranosus and the adductor magnus often arise by a common stem. The branch to the short head of the biceps and the lower branch to the semimembranosus arise near the middle of the thigh; the others arise at or near the lower border of the quadratus femoris—that is, the junction of the gluteal region and the back of thigh. Occasionally the sciatic nerve gives off a long articular twig which enters the popliteal fossa and takes the place of the lateral superior articular nerve, which, as a rule, is a branch of the lateral popliteal nerve.

Dissection.—To bring the adductor magnus more fully into view, detach the hamstring muscles from their origins and throw them aside. First, detach the common tendon of the biceps and semitendinosus. When that has been done, the attachment of the semimembranosus is displayed, and after the origin of that muscle has been again examined, it also must be detached. The posterior surface of the adductor magnus will then be fully exposed. Clean its posterior surface, but preserve its nerve from the sciatic nerve. Define its insertion—which is very extensive—into the back of the femur. At the same time secure the *perforating arteries*. They are a series of four arteries which perforate the adductor magnus at its insertion. Trace them laterally through the gluteus maximus and the short head of the biceps into the vastus lateralis.

The four **perforating arteries** arise in the medial side of the thigh from the profunda artery. They wind round the back of the femur, and end in the vastus lateralis. They anastomose with one another and with neighbouring arteries. They give branches to the adductor and hamstring muscles; and one or more of them send nutrient arteries into the femur. They will be seen more fully after the limb is removed from the trunk.

Anastomoses on the Back of the Thigh.—In a well-injected subject, a chain of arterial anastomoses can be traced from the gluteal region to the popliteal fossa, and the present is the best time to examine it. In the gluteal region, the superior gluteal artery anastomoses with the inferior gluteal, and the inferior gluteal with the terminal branches of the medial femoral circumflex artery. In the back of the thigh the chain of anastomoses is carried downwards by the medial and lateral femoral circumflex arteries anastomosing with the first perforating artery, and by anastomoses between the perforating arteries. The chain is completed distally by anastomoses between the lowest perforating arteries and the branches of the popliteal artery to the hamstring muscles.

At the end of the fifth day after the subject has been placed upon its face, the dissector must paint the various parts in the gluteal and thigh regions with the preservative solution, replace them in position, and fix the skin flaps over them with a few points of suture. On the morning of the following day he will find the body replaced on its back,

with the pelvis and thorax supported by blocks ; and he will proceed to dissect or complete the dissection of the medial side of the thigh, and to examine the hip joint.

MEDIAL SIDE OF THIGH

The group of adductor muscles on the medial side of the thigh, together with the blood-vessels and nerves associated with them, must next be dissected. As the dissection proceeds the following structures will be displayed :—

Muscles	Adductor longus.	Pectineus.
	Adductor brevis.	Gracilis.
	Adductor magnus.	Obturator externus.
Arteries	Profunda femoris (and its branches).	
	Obturator.	
Nerves	The two divisions of the obturator nerve.	
	The accessory obturator nerve, when present.	

The adductor muscles are disposed in three strata. The *anterior layer* is composed of the pectineus and the adductor longus, which lie in the same plane. Their adjacent borders touch each other near the pubis, but near the femur they are separated by a small interval The *second layer* is the adductor brevis alone ; and the *third* or *posterior layer* is the adductor magnus. The gracilis muscle, also an adductor, lies at the surface along the medial side of the thigh. It is a long, slender muscle, applied against the adductor brevis and adductor magnus.

The two divisions of the *obturator nerve* are interposed between the three muscular layers—the *anterior division* descending in front of the adductor brevis, the and *posterior division* behind it. At the lower or medial border of the adductor longus, a fine branch from the anterior division of the nerve makes its appearance ; it takes part in the formation of the subsartorial nerve plexus already dissected. The profunda artery is behind the adductor longus near the femur ; but it cannot be displayed fully until the limb is removed from the trunk.

Adductor Longus.—This muscle is placed on the medial side of the pectineus. It is triangular in shape, being narrow at its origin and expanded at its insertion. It arises from the front of the body of the pubis, immediately below the pubic crest (Fig. 127) by a short, strong, flat band

which is so curved upon itself that it is like a round tendon; and it is inserted into the linea aspera of the femur by a very thin aponeurosis. It is supplied by the *anterior division* of the *obturator nerve*. It acts like the adductor brevis (p. 294).

Dissection.—Divide the *adductor longus* one inch below its origin. Turn the proximal part upwards and note the character of the tendon. Turn the distal portion towards the femur, and

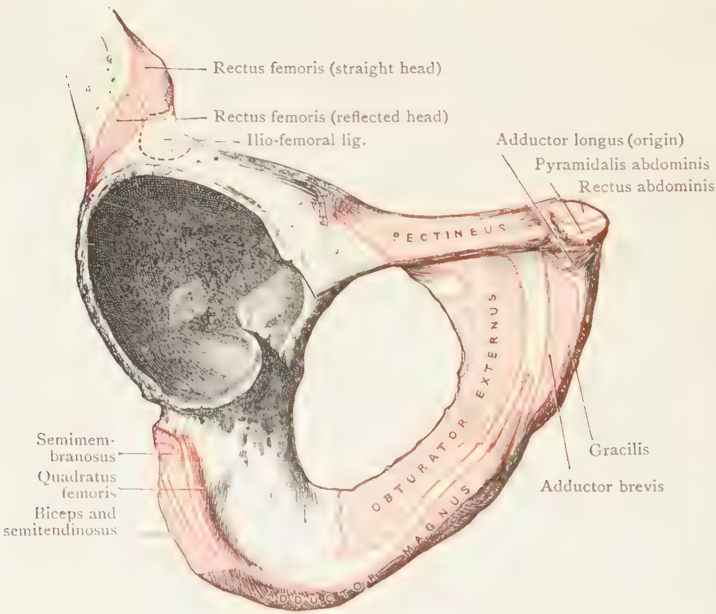


FIG. 127.—External Surface of the Os Pubis and Ischium, with Attachments of Muscles mapped out.

secure the nerve of supply. Clean both sides of the aponeurosis as far as possible, separating it from the vastus medialis and the adductor magnus, with both of which it is intimately connected.

Pectineus.—The pectineus is placed between the adductor longus and the psoas major. It is flat, and is rather broader at its origin than at its insertion. It has a fleshy origin, from the pectineal line and pectineal surface of the pubis (Fig. 127), and descends obliquely, laterally and backwards, to gain

insertion into the back of the femur into the upper half of a line that extends from the back of the lesser trochanter to the

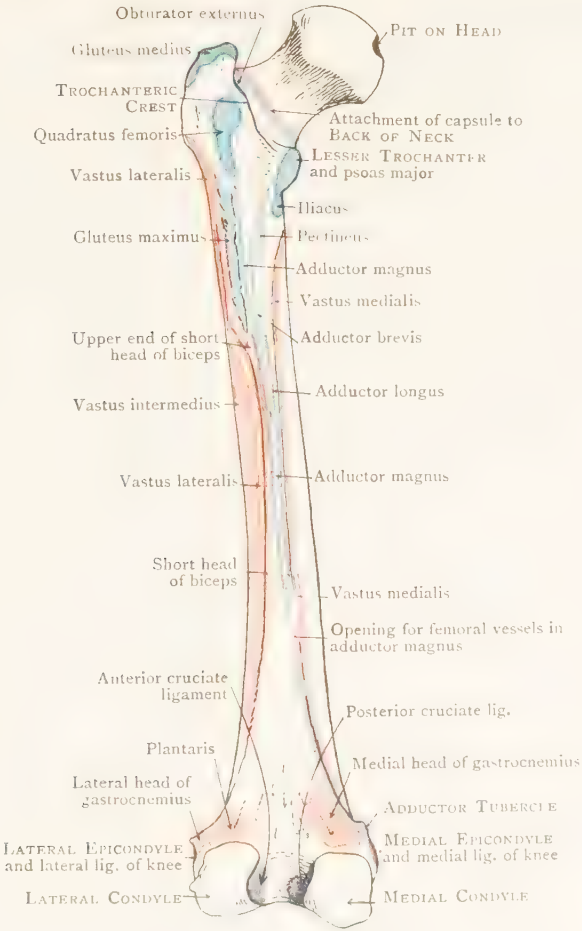


FIG. 128.—Back of Femur, with attachments of muscles mapped out.

linea aspera (Figs. 128, 132). It is supplied by the *femoral nerve*. The pectineus adducts the thigh and rotates it laterally. It also assists in flexion.

Dissection.—Detach the pectineus from its origin, and throw it towards its insertion; at its lateral margin, look for an *accessory obturator nerve* which is occasionally present. Care must also be taken not to injure (1) the anterior division of the obturator nerve, which lies behind the muscle, or (2) the medial circumflex artery

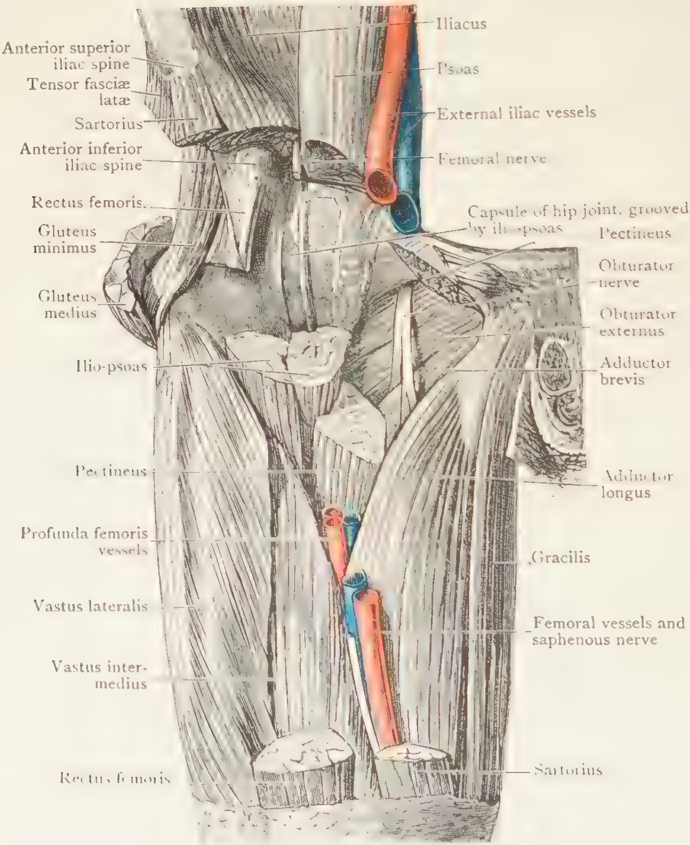


FIG. 129.—Dissection of the Front of the Thigh. The hip joint has been exposed by the removal of parts of the muscles which lie anterior to it.

which passes backwards between it and the psoas major (Fig. 134). Trace the *medial circumflex artery* still farther backwards, between the adductor brevis and the obturator externus. The *adductor brevis* is below the artery; the *obturator externus* is the fleshy mass above it, closely applied to the front of the pelvis. Clean both these muscles as far as possible.

Accessory Obturator Nerve.—This slender nerve, when present, arises either from the lumbar plexus or from the obturator trunk near its origin. It descends across the superior ramus of the pubis along the medial side of the psoas major into the thigh. If small, it ends in the hip joint or in the pectineus; if larger, it usurps the distribution of the obturator nerve to an extent that varies with its size (Fig. 130).

Medial Circumflex Artery.—This artery usually springs from the profunda femoris artery, at the same level as the lateral circumflex branch, but sometimes it springs directly from the femoral trunk. It passes backwards, out of the femoral triangle, between the psoas and the pectineus, and then between the obturator externus and the adductor brevis, to reach the back of the thigh, where, close to the lesser trochanter, it divides into an ascending and a transverse terminal branch. Before the main trunk divides it gives off:—(1) *muscular branches*, and (2) an *articular branch*, which enters the hip joint through the acetabular notch.

The *ascending terminal branch* runs obliquely upwards on the surface of the obturator externus under cover of the quadratus femoris; the *transverse terminal branch* runs backwards, between the quadratus femoris and the adductor magnus, to the hamstring muscles. Both terminal branches have been examined already in the gluteal region.

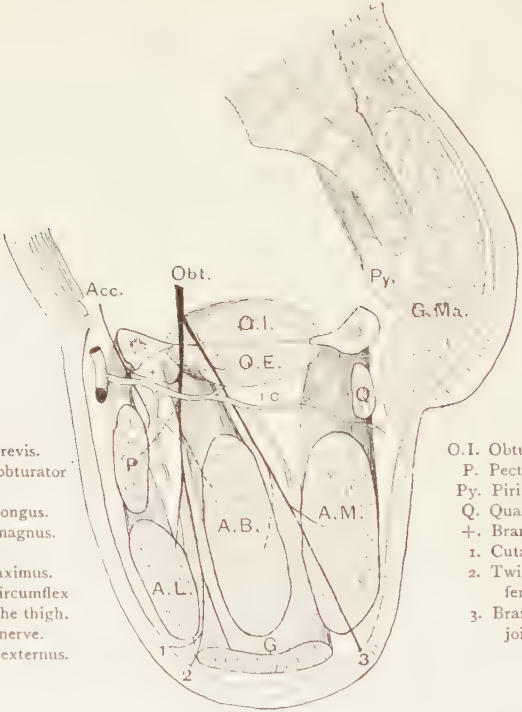
Branches of the Femoral Artery.—In every region of the thigh the dissector has met with branches of the femoral artery. It is well now that he should revert to this vessel and study its branches in the order in which they arise. The following Table may aid him in doing this:—

Superficial epigastric.		Superficial inguinal.
Superficial circumflex iliac		Superficial inguinal.
Superficial external pudendal		Superficial inguinal.
Deep external pudendal		
Profunda.	Lateral circumflex.	
	Medial circumflex.	
	First perforating.	
	Second perforating.	Nutrient to femur.
	Third perforating.	
	Fourth perforating (terminal).	
Unnamed muscular branches.		
Descending genicular artery.		

Adductor Brevis.—The adductor brevis is behind the adductor longus and the pectineus, and in front of the adductor magnus. It arises from the front of the os pubis below the origin of the adductor longus (Fig. 127). As it descends, it inclines backwards and laterally; and it is inserted, lateral to the pectineus and adductor longus, into the lower two-thirds of the line which extends from the lesser trochanter to the linea aspera (Fig. 132), and into the upper part of the linea aspera. It is supplied by the *obturator nerve*. Like all the other adductor muscles, it is an adductor, a flexor and a lateral rotator of the thigh.

Dissection.—Divide the adductor brevis close to its origin, and turn it towards its insertion, but do not injure the anterior

division of the *obturator nerve* which lies in front of it. When the muscle is reflected the posterior division of the nerve will be exposed. Trace it upwards to the obturator foramen, and downwards into the adductor magnus. Clean a further part of the *obturator externus*. Define the origin of the adductor magnus from the side of the pubic arch ; and clean its anterior surface as far as possible towards its insertion, separating it from the adductor brevis.



A.B. Adductor brevis.
Acc. Accessory obturator nerve.
A.L. Adductor longus.
A.M. Adductor magnus.
G. Gracilis.
G.Ma. Gluteus maximus.
I.C. Medial circumflex artery of the thigh.
Obt. Obturator nerve.
O.E. Obturator externus.

O.I. Obturator internus.
P. Pectineus.
Py. Piriformis muscle.
Q. Quadratus femoris.
+. Branch to hip joint.
1. Cutaneous branch.
2. Twig to walls of femoral artery.
3. Branch to knee joint.

FIG. 130.—Diagram to illustrate the distribution of the Obturator Nerve and the general disposition of the Adductor Muscles of the Thigh (Paterson).

Obturator Nerve.—The obturator nerve arises in the abdomen proper, from the lumbar plexus (Fig. 101), and descends into the pelvis. It escapes from the pelvis by passing, with its companion vessels, through the upper part of the obturator foramen (Fig. 131). While still within the foramen it divides into an anterior and a posterior division.

The *anterior division* enters the thigh over the upper border of the obturator externus muscle, and runs downwards on the anterior surface of the adductor brevis, behind the pectineus and adductor longus. It gives branches to three muscles, viz., the adductor longus, the adductor brevis, and the gracilis. Very rarely, it supplies a twig to the pectineus. In addition to these branches it gives off—(1) an *articular branch* to the hip joint (Fig. 130. +);

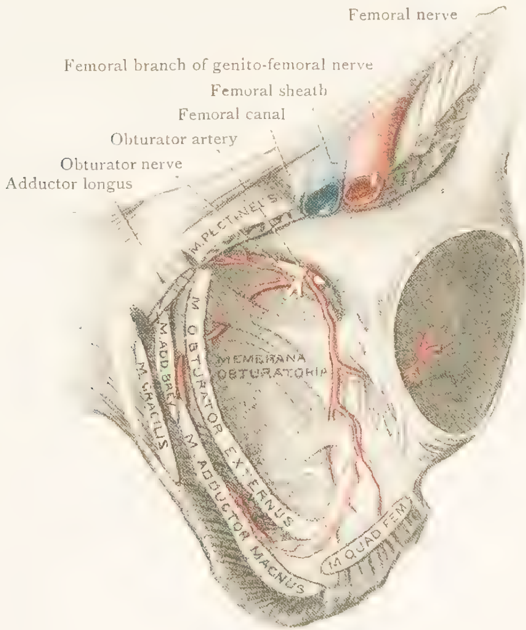


FIG. 131.—Dissection to show the Structures surrounding the Obturator Foramen of the Hip Bone.

(2) a fine twig, which appears at the distal border of the adductor longus, joins the subsartorial plexus and then becomes cutaneous; and (3) a *terminal twig*, which goes to the femoral artery—(Fig. 130)—and breaks up into fine filaments upon its walls.

The *posterior division* of the obturator nerve, as it enters the thigh, pierces the upper border of the obturator externus. It

descends between the adductor brevis and the adductor magnus, and is expended chiefly in the supply of the latter. It gives also, however, a branch to the obturator externus and an articular branch to the knee joint. This *genicular branch* pierces the lower part of the adductor magnus, close to the linea aspera, and descends over the popliteal artery to the back of the knee joint.

Gracilis.—This long, slender muscle lies along the medial side of the thigh and knee. It springs, by a thin, wide tendon, from the lower half of the body of the pubis, close to the symphysis, and also from the upper half of the side of the pubic arch (Fig. 127). It ends in a thin, rounded tendon which inclines forwards, below the knee, and then expands to be inserted into the upper part of the medial surface of the tibia, under cover of the tendon of the sartorius, (Fig. 125, p. 285). Two inter-communicating bursæ separate the expanded tendon of the gracilis from the medial ligament of the knee joint, and from the tendon of the sartorius. The gracilis is supplied by the *anterior division* of the *obturator nerve*. It adducts the thigh, flexes the knee joint and rotates the leg medially.

Adductor Magnus.—The adductor magnus is one of the most powerful muscles of the thigh. It is a thick, flat, fleshy mass which springs from the side of the pubic arch and the lower part of the ischial tuberosity (Figs. 127, 131). The part from the arch spreads out to gain an extensive linear insertion into the back of the femur, being attached to the medial side of the gluteal tuberosity, to the linea aspera, to the medial supracondylar ridge; the more medial bundles are the more horizontal; the more lateral are the more oblique in direction (Figs. 128, 140). The part from the tuberosity descends almost vertically and forms the thick, postero-medial border of the muscle; in the distal third of the thigh, it ends in a strong, rounded tendon which is inserted into the adductor tubercle (Figs. 119, 128). This tendon is further attached to the femur by the medial intermuscular septum, which stretches between it and the medial supracondylar ridge.

At the gluteal tuberosity and the linea aspera, the insertion is interrupted by the passage of the perforating vessels. At these spots, tendinous fibres are developed in the muscle, and they arch over the vessels to protect them. The

opening for the femoral vessels is in series with those arches, and is situated at the supracondylar ridge about the junction of the middle and lower thirds of the thigh (Fig. 140).

The adductor magnus has a double nerve supply. The part inserted into the adductor tubercle is associated at its origin with the hamstrings and is supplied by the *sciatic nerve*; the rest of the muscle—the true adductor part—is supplied by the posterior branch of the *obturator nerve*.

The adductor portion acts like the other adductor muscles—that is, it adducts the thigh, rotates it laterally, and helps to flex the hip joint. The hamstring portion extends the hip joint.

Dissection.—Detach the adductor magnus from the side of the pubic arch, and complete the cleaning of the obturator externus muscle.

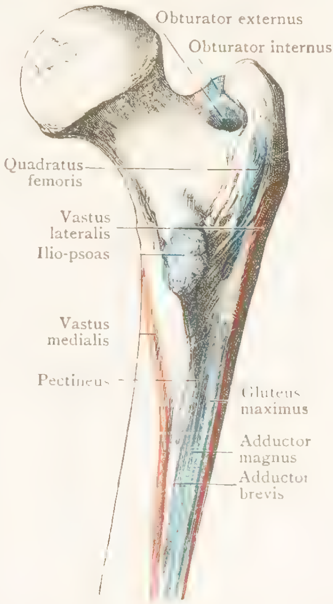


FIG. 132.—Posterior Aspect of Proximal Portion of Femur, with the Attachments of Muscles mapped out.

Obturator Externus.—This flat, fan-shaped muscle overlies the obturator membrane, which closes the obturator foramen of the hip bone. It springs from the medial half of the obturator membrane, and also from the medial and lower margins of the foramen (Figs. 127, 131). It passes backwards and laterally, below the neck of the femur and the capsule of the hip joint, and then curves upwards and laterally on to the back of the neck of the femur, to end in a stout tendon which obtains insertion into the trochanteric fossa (Figs. 128, 132). This tendon has been examined in the dissection of the gluteal region.

The obturator externus is supplied by the *posterior division* of the *obturator nerve*. It is a flexor, an adductor and a lateral rotator of the thigh.

Dissection.—Detach the obturator externus carefully from its origin in order to expose the *obturator artery* and its terminal branches. Release the posterior division of the *obturator nerve* from the substance of the muscle, and avoid injury to its anterior division.

Obturator Artery.—The obturator artery arises in the pelvis from the internal iliac (hypogastric). It accompanies the nerve through the obturator foramen, and as soon as it enters the thigh, it divides into two terminal branches which diverge from each other and form an arterial circle on the obturator membrane under cover of the obturator externus. Both branches give twigs to the neighbouring muscles; and the *posterior branch* sends an *articular twig* through the acetabular notch into the hip joint. When the joint is opened this twig may be followed, in a well-injected subject, into the femur along the ligament of the head of the femur.

Psoas Major and Iliacus.- Both the psoas major and the iliacus muscles arise within the abdomen, and they enter the thigh behind the inguinal ligament. A tendon appears on the lateral side of the psoas major, and finally the whole muscle ends in the tendon, which is inserted into the lesser trochanter of the femur. The iliacus lies at the lateral side of the psoas, and is inserted, by fleshy fibres, into the tendon of the psoas, into the lesser trochanter and the surface of the femur below it. The united iliacus and psoas at first descend over the front of the capsule of the hip joint, and then pass backwards underneath it to reach their insertion. A synovial *bursa* intervenes between them and the front of the capsule, and facilitates the play of the united muscle over the joint. The bursa may communicate with the joint through an aperture in the capsule (Figs. 129, 134).

The action of the psoas major and the iliacus depends upon the position of the hip joint when the muscles are in action. If the thigh is extended they flex it, and rotate it medially until flexion is complete; they then rotate it laterally. In surgical practice, the important rotation is the lateral one; when the femur is broken below the trochanter, the ilio-psoas flexes the proximal fragment at once and then rotates it laterally

Dissection.—Divide the femoral vessels and nerve below the inguinal ligament, and tie them separately to a small piece of wood. Cut through the sartorius and the rectus femoris, about two inches from their origins, and turn them aside. The

ilio-psoas must next be divided near its insertion and the two parts turned upwards and downwards. This will expose the capsule of the hip joint and the bursa. Open the bursa and ascertain its extent with the finger, and note whether or not it communicates with the joint.

Turn aside the tensor fasciæ latæ. If the gluteus minimus still adheres to the capsule, release it, and throw it laterally and downwards, but do not detach it from the trochanter. Raise the upper part of the rectus femoris, and clean its reflected head. Lastly, clean the anterior part of the capsule of the hip joint.

Hip Joint

The **hip joint** (articulatio coxæ) is the most perfect example of a ball-and-socket joint in the body. It does not allow so free a range of movement as that which takes place at the shoulder joint, but what it loses in this respect it gains in strength and stability. Its great strength and security depend -(1) upon the depth of the acetabulum and the thorough manner in which the head of the femur is received into it; (2) upon the tension and power of the ligaments; (3) upon the length and oblique direction of the neck of the femur; (4) upon the strength of the surrounding muscles; and (5) upon atmospheric pressure.

Ligaments of the Hip Joint. These are:

1. Capsular ligament.
   - Ilio-femoral ligament.
   - Pubo-femoral ligament.
   - Ischio-femoral ligament
   - Zona orbicularis.
2. Labrum acetabulare.
3. Transverse ligament of acetabulum.
4. Ligament of the head of the femur.

The capsular ligament and the ligament of the head (lig. teres) are attached to both bones of the joint. The transverse ligament and the labrum acetabulare are connected with the hip bone only; the transverse ligament partially fills the acetabular notch, whilst the labrum encircles the mouth of the acetabulum, and serves to deepen it still further.

The capsular ligament is exceedingly strong, and surrounds the joint on all sides. *Proximally*, it is attached around the acetabulum :—above and posteriorly, directly to the hip bone, just beyond the rim of the cavity; anteriorly, to the labrum; and below, to the transverse ligament. *Distally*, it clasps the neck of the femur: anteriorly, it is attached to

the whole length of the trochanteric line, and to the root of the greater trochanter; this attachment is very firm and strong; posteriorly, it falls short of the trochanteric crest by about half an inch, and its attachment to the neck of the femur is weak.

When the capsule of the hip joint has been carefully cleaned, it will be seen that the fibres which compose it run

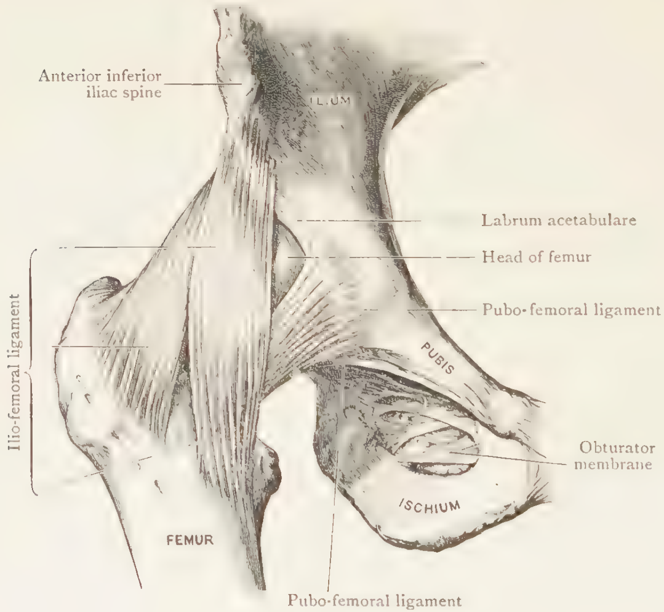


FIG. 133.—Dissection of Hip Joint from the front.

in two different directions. The majority pass obliquely from the hip bone to the femur. There are, however, other fibres which lie more or less at right angles to the oblique fibres. They constitute the *zona orbicularis* and are seen to advantage in the posterior and inferior parts of the capsule, where they were noted during the dissection of the gluteal region (p. 270). The oblique fibres are most massed on the front of the joint.

Certain thickened portions of the capsule are described under special names.

They are :—

1. Ilio-femoral ligament.
2. Pubo-femoral ligament.
3. Ischio-femoral ligament.
4. Zona orbicularis.

The *ilio-femoral ligament* is placed over the front of the joint, and is the thickest and most powerful part of the capsule.

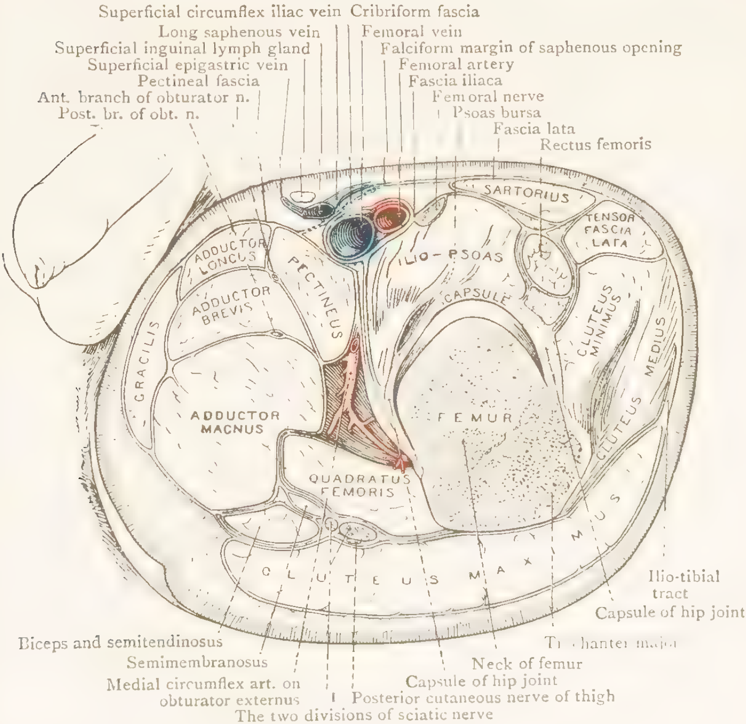


FIG. 134.—Dissection of an oblique transverse Section through upper part of Thigh showing the relation of the Fascia to the Muscles.

Proximally, it is attached to the anterior inferior iliac spine and to the depressed surface immediately lateral to that spine. Distally, it is attached to the trochanteric line of the femur. At its upper or iliac end it is a single mass of fibres, but as it descends, it divides into a *lateral* and a *medial* band (Fig. 133).

The lateral and shorter band is implanted into the upper part of the trochanteric line and to the adjacent part of the

greater trochanter. The more medial and longer band is almost vertical, and its distal end is attached to the lower part of the trochanteric line. The thinner portion, between the two bands, is perforated by an articular twig from the ascending branch of the lateral femoral circumflex artery.

The ilio-femoral ligament is fully a quarter of an inch thick, and is one of the strongest ligaments in the body—its only rival being the interosseous sacro-iliac ligament. A strain varying from 250 lbs to 750 lbs is required for its rupture (Bigelow). It is rarely torn asunder in dislocation of the hip joint, and, consequently, the surgeon is able in most cases to overcome the displacement by manipulation.

The *pubo-femoral ligament* is the name applied to fasciculi which spring from the pubic bone and the obturator membrane, and join the lower and anterior part of the capsule. When the bursa of the ilio-psoas is continuous with the cavity of the joint, the aperture of communication is placed between this band and the ilio-femoral ligament.

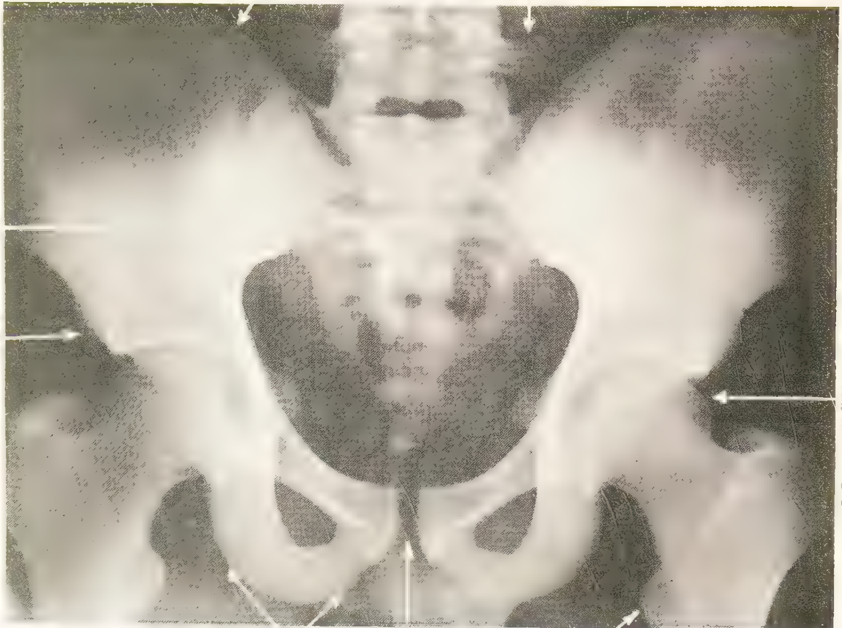
The *ischio-femoral ligament* is a comparatively weak band which springs from the ischium, below the acetabulum, and passes upwards and laterally, to blend with the posterior part of the capsule.

The *zona orbicularis* is composed of circular fibres which are most distinct in the posterior part of the capsule. It encircles the neck of the femur posteriorly and below, but is lost as it is traced towards the upper and anterior parts of the capsule.

The dissector has already noted the close connexion between the capsule and the tendon of the gluteus minimus and the reflected head of the rectus femoris. Reinforcing fibres are contributed to the capsule by both of those tendons.

Movements permitted at the Hip Joint.—Before the capsule of the joint is opened, the range of movement which is permitted at the hip joint should be tested. *Flexion*, or forward movement, is very free, and is checked by the anterior surface of the thigh coming into contact with the abdominal wall. *Extension*, or backward movement, is limited by the ilio-femoral ligament. That powerful ligament has a most important part to play in preserving the upright attitude with the least possible expenditure of muscular exertion. In the erect posture the line of gravity falls slightly behind the line joining the central points of the two hip joints. In the upright attitude the ilio-femoral ligaments are tense, and prevent the pelvis from rolling backwards on the heads of the femora. *Abduction*, or lateral movement of the limb, is checked by the pubo-femoral ligament. *Adduction*, or medial movement (*e.g.* as in crossing one thigh over the other), is limited by the lateral portion of the ilio-femoral ligament and

PLATE XIX


Transverse p ... fifth lumbar verte ... a
Head of Femur ; pit on head ; acetabulum ; and ischial spine
Greater

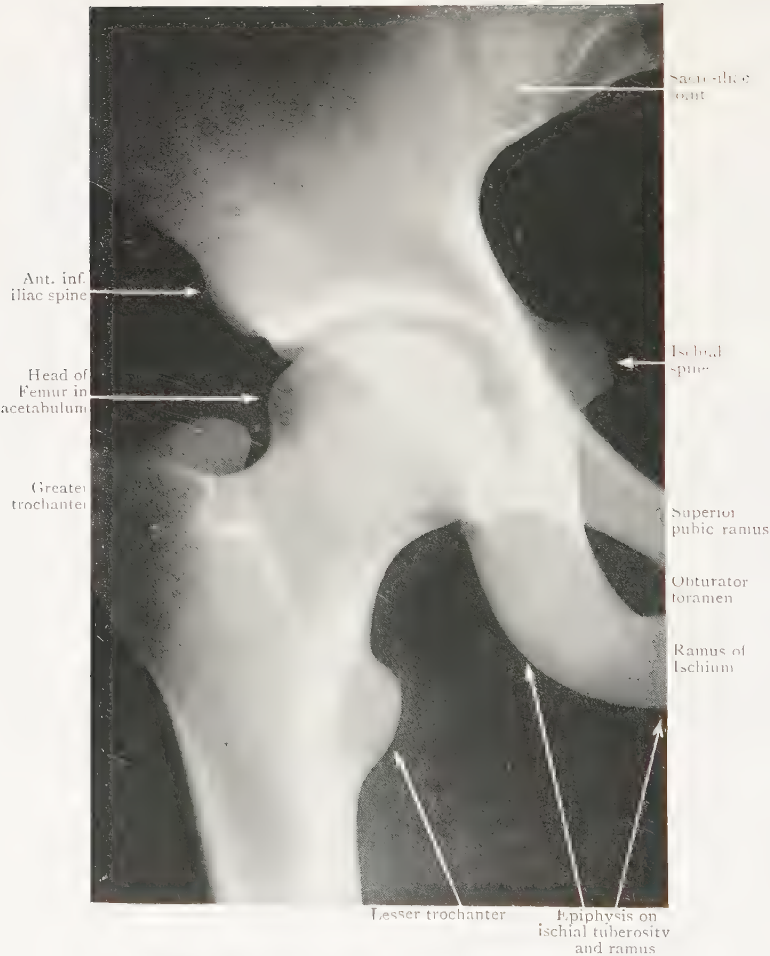


FIG. 136. Radiograph of Hip of youth aged 17.

(Dr. J. Duncan White.)

All three epiphyses of the Femur are united. Note the continuity of the lines of the lower borders of the superior pubic ramus and the neck of the femur, seen also in the next figure.

PLATE XXI

FIG. 137. Radiograph of Hip of boy aged 7

(Dr. J. Duncan White.)

The epiphysis of the lesser trochanter of the Femur has not yet appeared.

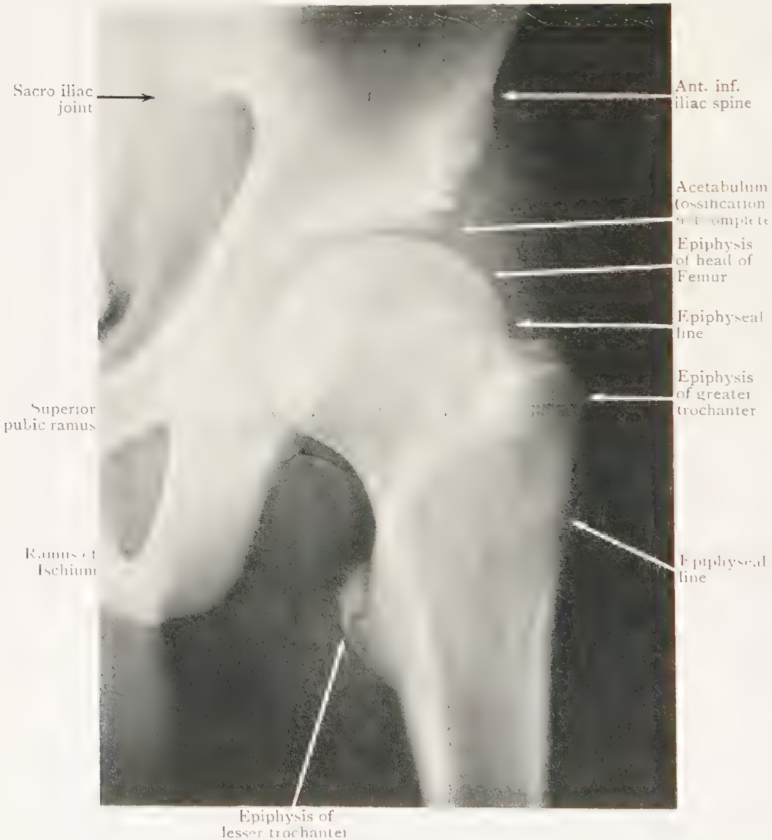


FIG. 138. -Radiograph, Hip of boy aged 14.

Note that the edge and floor of the acetabulum are not yet completely ossified, and that all three epiphyses of the upper end of the Femur are present.

the upper part of the capsule. *Rotation medially* tightens the ischio-femoral ligament, and is therefore, in a measure, restrained by it. *Rotation laterally* is limited by the lateral portion of the ilio-femoral ligament. In *circumduction*, which is produced by combination of the movements of flexion, abduction, extension, and adduction, different parts of the capsular ligament are tightened at different stages of the movement.

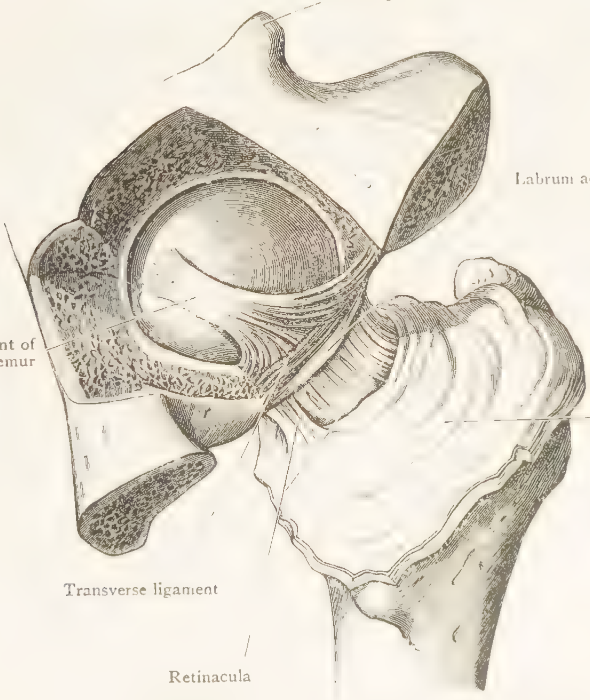


FIG. 139.—Dissection of Hip Joint from behind. The bottom of the acetabulum has been removed to show the lig. of head of femur.

Flexors.—(1) Ilio-psoas, (2) rectus femoris, (3) adductor longus and brevis and pubic part of adductor magnus, (4) pectineus, (5) sartorius.

Extensors.—(1) Gluteus maximus, (2) hamstrings, (3) ischial fibres of adductor magnus, (4) posterior fibres of gluteus medius.

Adductors.—(1) The three adductors, (2) lower fibres of gluteus maximus, (3) quadratus femoris, (4) obturator externus, (5) sartorius, (6) pectineus.

Abductors.—(1) Gluteus medius and minimus, (2) tensor fasciæ latæ, (3) upper fibres of gluteus maximus.

Medial Rotators.—(1) Anterior fibres of gluteus medius and minimus, (2) ilio-psoas, (3) pectineus, (4) ischial fibres of adductor magnus.

Lateral Rotators.—(1) Lower fibres of gluteus maximus, (2) quadratus femoris, (3) obturator externus and internus and gemelli, (4) piriformis, (5) the three adductors, (6) ilio-psoas.

It must be noted that the obturator muscles, the piriformis, and the gemelli, which act as lateral rotators when the body is erect, become abductors when the joint is flexed, and that the ilio-psoas is a flexor of the hip joint and a medial rotator of the thigh until flexion is almost complete, when it becomes a lateral rotator.

Dissection.—The hip joint should now be opened. Isolate the *ilio-femoral ligament* by incisions along its borders, and then remove all other parts of the capsule. The object of this dissection is to enable the dissector to appreciate the thickness and great strength of the ilio-femoral ligament. Divide it, when it has been examined.

The **transverse ligament of the acetabulum** is a strong band of fibres that bridges across the acetabular notch, and is attached to the margins of the notch. It completes the rim of the acetabulum, and converts the notch into a foramen through which vessels and nerves enter the joint.

The **labrum acetabulare** is a firm fibro-cartilaginous ring which is fixed to the rim of the acetabulum; it deepens the cavity of the acetabulum, and at the same time narrows its mouth to a slight extent. The labrum fits closely upon the head of the femur, and, acting like a sucker, exercises an important influence in retaining it in place. Both surfaces of the labrum are covered with synovial membrane; its free margin is thin, but it is much thicker at its attachment to the acetabular rim.

The **ligament of the head of the femur** has long been called the "ligamentum teres" (*Teres* = round), but it is a flat, fan-shaped band. Its narrow end is implanted into the pit on the head of the femur; its flattened end is bifid, and is fixed to the margins of the acetabular notch, and also to the transverse ligament. This attachment can be defined by the removal of the synovial membrane and some areolar tissue. The ligament is surrounded by a prolongation of the synovial membrane; and a small artery runs along it to the head of the femur.

It is difficult to understand the part which the ligament plays in the mechanism of the hip joint. It presents very different degrees of strength in different subjects. It becomes very tense when the thigh is slightly flexed and then adducted—which, however, is an attitude seldom taken up.

Synovial Membrane and Interior of the Joint.—A mass of soft fat occupies the non-articular fossa of the acetabulum. Upon this the ligament of the head of the femur is placed, and articular twigs from the obturator vessels and nerve enter it by passing through the acetabular notch.

The **synovial membrane** lines the inner surface of the capsular ligament. From the capsular ligament, it is reflected on to the neck of the femur, and it clothes the bone as far as the margin of the articular cartilage which covers the head. Along the line of reflexion, some fibres of the capsular ligament run upwards on the neck of the femur and raise up ridges of the synovial membrane. These fibres are termed the *retinacula* of the neck of the femur.

The *retinacula* are of some surgical importance. In intracapsular fracture of the neck of the femur they may escape rupture, and they may then, to some extent, help to retain the fragments in apposition—hence the name *retinacula*. Examinations of this class of fracture must, therefore, be conducted gently, lest this ligamentous connexion should be ruptured, and the fragments be permanently displaced.

At the acetabular attachment of the capsule, the synovial membrane is reflected on to the labrum acetabulare and invests both its surfaces. It covers also the articular surface of the transverse ligament and the cushion of fat which occupies the acetabular fossa. Lastly, it gives a tubular investment to the ligament of the head of the femur.

Blood-vessels and Nerves.—The *arteries* that supply the hip joint are derived from the gluteal, circumflex and obturator arteries. The *nerves* come from (1) the nerve to quadratus femoris, (2) the femoral, through the nerve to rectus femoris, (3) the anterior division of the obturator nerve, and (4), occasionally, the accessory obturator.

Removal of the Lower Limb.—Divide the ligament of the head of the femur, and remove the limb from the trunk. Take the limb to one of the tables set aside for the dissection of separate parts, and revise the attachments of muscles and complete the dissection of the thigh.

Trochanteric and Adductor Muscles and Profunda Femoris Artery

The student will now clean the distal parts of the muscles attached to the trochanters, and will define and examine their insertions. He will then be enabled also to examine the femoral attachments of the capsular ligament of the hip joint

more satisfactorily. When that has been done, he will complete the dissection of the pectineus and the adductors, and will expose the distal part of the profunda artery and the origin of its perforating branches.

Dissection.—Identify the muscles which are inserted into the greater trochanter. They are—*gluteus minimus* and *medius*, *quadratus femoris*, *piriformis*, *obturator internus* and *externus*. Lift them up, clean both sides of each of them in turn, and define their insertions. Do not be satisfied till each muscle hangs quite freely from its insertion.

Deal in like manner with the *ilio-psoas*, which is inserted chiefly into the lesser trochanter.

Then re-examine the *capsule* of the hip joint. Note the femoral attachment of the *capsular ligament*. Evert the capsule, and note how the *synovial membrane* is reflected off the capsular ligament, and extends as a close-fitting tube over the neck of the femur up to the head. Strip off the synovial membrane to display the *retinacula*.

Come now to the adductor region. Identify the pectineus and the adductors longus, brevis, magnus. Clean the *pectineus* first —both sides of it, down to the bone. Clean the *adductor longus* next ; but do so very carefully because of its extreme thinness as it approaches the femur. The vastus medialis is in front of it, and takes origin from it ; the adductor brevis and magnus are behind it, and adhere to it. Separate it carefully from them (sacrificing portions of them, if need be) till both sides are free down to the bone.

As you separate the adductor longus from the other adductors you will find the *profunda vessels* behind the longus, close to the femur the vein in front of the artery. Clean the profunda vein and preserve it, but remove its tributaries. Then, clean the artery. Divide the branches which it gives to muscles in this situation ; but clean and preserve those of its branches which cling to the femur : they are the *perforating arteries*.

Next, clean both sides of the *adductor brevis* down to its insertion, and then the *adductor magnus*.

Now, refer to the book and verify the statements which have been made about the attachments of all those muscles ; and then proceed to the study of the profunda vessels.

Profunda Femoris Artery.—This large vessel is the chief artery of supply to the muscles of the thigh. It arises, in the femoral triangle, from the postero-lateral side of the femoral artery, about an inch and a half or two inches below the inguinal ligament. It descends with a curve medially which brings it behind the femoral vessels in the lower part of the triangle ; it leaves the triangle by passing through the floor between the pectineus and the adductor longus, and then descends behind the adductor longus, close to the femur ; by giving off large branches it is rapidly reduced in size, and it ends, a little below the middle of the

thigh, as a fine terminal vessel, called the *fourth perforating artery*, which passes backwards through the adductor magnus.

At first, the profunda lies lateral to the femoral artery, on the iliacus, behind the skin and fasciæ ; as it inclines medially, it passes on to the pectineus, behind its own vein and the femoral vessels ; after it leaves the triangle, it lies on the adductor brevis and the adductor magnus, behind its own vein and the adductor longus ; and that muscle separates the profunda vessels from the femoral vessels.

The branches of the profunda femoris are the *lateral* and *medial circumflex* arteries, the four *perforating* arteries, and unnamed *muscular* arteries.

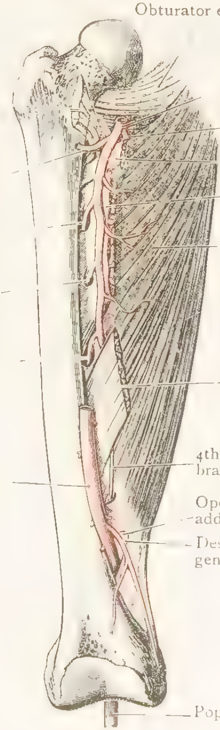


FIG. 140.—The Profunda Femoris Artery and its Branches.

The **circumflex arteries** have been studied already (pp. 243, 293). The **muscular branches** are inconstant in origin, number and size. They supply the adductor muscles, and some of them pierce the adductor magnus to reach the hamstring muscles.

The four **perforating arteries** arise in series from the profunda—the first, when it slips behind the adductor longus, and the fourth as its terminal branch. They wind round the back of the femur, sometimes grooving the bone, and they all end in the vastus lateralis. As they pierce the muscles attached to the back of the femur, they are protected by fibrous arches. On their way, they give branches to the adductors and the hamstrings ; the second or the third sends a *nutrient artery* into the femur, and another nutrient artery may arise from the fourth.

To reach the vastus lateralis, the *first* perforating artery pierces the adductors brevis and magnus and the gluteus maximus ; the *second*

pierces the adductors brevis and magnus and the short head of the biceps. The *third* and the *fourth* arise below the level of the adductor brevis; they pierce the adductor magnus and the short head of the biceps.

When the study of the medial side of the thigh is completed, the student will proceed to the examination of the leg and the foot, beginning with their surface anatomy.

LEG AND FOOT

Surface Anatomy.—The head of the fibula, the condyles and tubercle of the tibia have been examined already. Identify them again.

The malleoli are the prominences at the sides of the ankle, and they grip the talus between them. The **medial malleolus** is a thick, downward projection from the lower end of the tibia; the **lateral malleolus** is the lower end of the fibula. Their posterior surfaces are in the same vertical transverse plane. The lateral malleolus is the narrower and therefore does not extend forwards so far as the medial one does, but it juts downwards farther, and, therefore, articulates with a larger area of the talus.

The **neck of the fibula** and the greater part of its **shaft** are buried among muscles, but can be felt through them. The lower part of the shaft is subcutaneous, and is the bone felt above the lateral malleolus.

The shin is the **anterior border of the shaft of the tibia.** It is inconspicuous; but it is subcutaneous, and is readily felt if the finger is passed along it. It runs slightly sinuously from the tubercle of the tibia to the anterior margin of the medial malleolus; it is a sharp edge except towards its lower end. The **medial surface of the tibia,** wide and flat, is easily felt from end to end. Its uppermost part is covered by the tendons of the sartorius, gracilis and semitendinosus; the rest is subcutaneous. The **medial border** of the tibia also is easily felt from end to end; the saphenous nerve and the long saphenous vein run along it.

On the back of the leg, the fleshy prominence of the calf is due to the gastrocnemius and the underlying soleus. These two muscles are thrown into contraction when the heel is raised—*e.g.*, in standing on the toes. The outlines of the two heads of the gastrocnemius are then clearly seen, if the

limb is thin ; it is obvious also that the soleus reaches farther down, and that, at the middle of the calf, it is wider than the gastrocnemius. The muscles taper inferiorly to become continuous with the **tendo calcaneus**, which is the strong, thick tendon above the heel. Grasp the tendo calcaneus between finger and thumb. Note that it is nearly an inch behind the bones of the leg, the interval being filled with fat and fibrous tissue. Press the fingers on the anterior wall of the hollows at the sides of the tendo calcaneus : the backs of the malleoli can be felt, though tendons cover them ; and, on the medial side, the pulse of the **posterior tibial artery** may be felt in the living limb.

The bone of the heel is the **calcaneum.** Grip its posterior part between finger and thumb. The **lateral** and **medial tubercles** of its lower surface make low, blunt prominences on the sides near the sole. Its **lateral surface** is nearly all subcutaneous, and is easily felt below the lateral malleolus as a wide surface extending forwards from the back of the heel for two inches or more. The **peroneal tubercle** (when present) is felt as a little prominence about a finger's breadth below the lateral malleolus. On the medial side, the **sustentaculum tali** provides the bony resistance felt a thumb's breadth below the medial malleolus.

The **talus** rests on the upper surface of the calcaneum. Its *body* is hidden below the tibia, between the malleoli ; but when the foot is extended (*i.e.* when the toes are pointed) the anterior part of the body protrudes from below the tibia Invert the foot (*i.e.* twist it so that the sole looks medially) : the *head* of the talus then makes a rounded prominence about an inch in front of the lateral malleolus ; and, lateral to the head of the talus, the anterior end of the calcaneum makes an uneven projection.

On the medial side of the foot, the landmark most often referred to is the **tuberosity of the navicular bone.** It makes a prominence, blunt and indistinct but easily felt, an inch or an inch and a half below and in front of the medial malleolus, about midway between the back of the heel and the root of the big toe, at the level of the lip of the shoe. The bones felt in front of the tuberosity are, first, the **medial cuneiform** bone, and then the **first metatarsal** bone.

On the lateral side, the tuberosity of the fifth metatarsal bone is a prominent landmark, midway between the point

of the heel and the root of the little toe. The **cuboid bone** lies hidden in the side of the foot between that tuberosity and the calcaneum. The head of the fifth metatarsal bone or the **root of the little toe** is at the widest part of the foot, and is often a rounded bulging. Note that it is much farther back than the root of the big toe, and that, when the foot is shod, it is so far from the toe of the shoe that it is liable to be mistaken for the base of the fifth metatarsal bone.

On the dorsum of the foot, the metatarsus and the anterior part of the tarsus are under the extensor tendons and the extensor digitorum brevis muscle ; but the **metatarsal bones** can be felt individually through them. The **extensor digitorum brevis** forms the soft, fleshy pad in front of the lateral malleolus ; and, when the foot and toes are raised, the tendons spring up, and can be individually recognised by the student after he has dissected the region. Unlike the joints of the fingers, the joints of the toes do not have landmarks to indicate their positions ; their positions are ascertained by manipulation.

In the sole of the foot, the soft parts are so thick that there are no bony landmarks. The middle of the medial part of the sole is raised from the ground ; therefore, that part presents a wide concavity, which, however, is flattened down and more or less obliterated in the condition known as "Flatfoot". The concavity is bounded posteriorly by the **pad of the heel**, and laterally by the elevation that underlies the calcaneum, cuboid and fifth metatarsal bone. The anterior boundary is the **ball of the foot**, which underlies the metatarso phalangeal joints ; its medial part is the **ball of the big toe**, whose large size is due chiefly to the two sesamoid bones that lie on the plantar surface of the joint.

The smaller toes are usually flexed so permanently that the only parts seen in the sole are the pads that cover the terminal phalanges ; the other phalanges are hidden in a narrow groove. But the groove widens medially, so that the other phalanges of the second and first toes can be felt.

Front of Leg and Dorsum of Foot.

It is convenient to dissect the dorsum of the foot at the same time as the front of the leg. The following parts are exposed:—

1. Superficial veins.
2. Cutaneous nerves.
3. Deep fascia, with its retinacula and intermuscular septa.
4. Tibialis anterior.
5. Extensor digitorum longus.
6. Peroneus tertius.
7. Extensor hallucis longus.
8. Anterior tibial vessels.
9. Perforating branch of the peroneal artery.
10. Anterior tibial nerve.
11. Recurrent genicular branch of lateral popliteal nerve.
12. Extensor digitorum brevis.
13. Dorsalis pedis vessels.

Dissection.—Reflexion of Skin.—Raise the knee on a block; extend the foot, and fasten it to the table with hooks. Reflect the skin from the lateral and medial sides of the leg as well as from the front. *Incisions* :—(1) a vertical cut along the middle line of the leg and dorsum of the foot to the root of the middle toe; (2) a transverse incision across the ankle joint; (3) a transverse incision across the roots of the toes.

Raise the four flaps of skin, thus mapped out (10, 11, 12, 13, Fig. 98, p. 211), from the subjacent fatty tissue, and dissect out the superficial veins and nerves.

Superficial Fascia.—The superficial fascia of the front and the medial and lateral sides of the leg and the dorsum of the foot presents no peculiar features; and it contains, as a rule, only a moderate amount of fat.

The **veins** found in it during the dissection are :—

1. The dorsal digital veins.
2. The dorsal venous arch.
3. The distal parts of the long and short saphenous veins.

The **cutaneous nerves** to be secured are :—

1. Lateral cutaneous nerve of calf.
2. Sural nerve.
3. Saphenous nerve.
4. Musculo-cutaneous nerve.
5. Anterior tibial nerve.

Dissection.—The *lateral cutaneous nerve of the calf* was displayed in the dissection of the popliteal space. Trace it now to its termination on the antero-lateral aspect of the leg.

Dissect the cutaneous veins next, for, on the dorsum of the foot, they lie more superficially than the nerves, and in other situations they serve as guides to the nerves. Begin with the *dorsal venous arch*. It lies across the anterior part of the metatarsus. Follow it to the medial border of the foot, where it joins the commencement of the *long saphenous vein*. Next, follow that vein upwards to the medial border of the tibia. Do not follow it farther at present, but secure the *saphenous nerve*, which lies close to it, and follow the nerve into the foot.

Now, follow the dorsal venous arch to the lateral margin of the foot, where it joins the commencement of the *short saphenous vein*. Follow the short saphenous vein backwards below the lateral malleolus, and there secure the *sural nerve*, which lies

adjacent to the vein. Follow the sural nerve to the little toe, and, about the middle of the lateral border of the foot, secure the communicating twig which it gives to the lateral branch of the musculo-cutaneous nerve.

Come back to the dorsal venous arch. Find the *dorsal digital veins*, and trace them on to the toes.

Now, cut down through the fat, at the junction of the middle and distal thirds of the leg, about an inch to the medial side of the fibula, and secure the trunk of the *musculo-cutaneous nerve* as it pierces the deep fascia. Follow it downwards to its division into medial and lateral branches, and then trace them and their subdivisions to their terminations on the toes.

Lastly, dissect in the fascia between the first two metatarsal bones and find the terminal, *cutaneous branch of the anterior tibial nerve* as it pierces the deep fascia ; trace it and its branches to the adjacent sides of the first and second toes.

Cutaneous Veins. There are two *dorsal digital veins* in each toe—one on each side of the dorsum of the toe. The medial dorsal digital vein of the big toe and the lateral dorsal digital vein of the little toe join the ends of the dorsal venous arch. The two dorsal digital veins which run along the adjacent sides of each of the four interdigital clefts unite at the apices of the clefts to form a common stem, and the four stems thus formed end in the dorsal venous arch.

The *dorsal venous arch* lies in the superficial fascia on the anterior parts of the shafts of the metatarsal bones, superficial to the terminal branches of the musculo-cutaneous nerve. Its medial end joins the medial dorsal digital vein of the big toe to form the long saphenous vein ; and its lateral end unites with the lateral dorsal digital vein of the little toe to form the short saphenous vein.

The *short saphenous vein* runs backwards below the lateral malleolus, and then upwards behind it into the leg.

The *long saphenous vein* passes backwards along the medial side of the foot, and ascends in front of the medial malleolus into the leg, where it passes obliquely across the distal third of the tibia to reach its medial border, along which it ascends. In the lower part of the leg, the long saphenous vein and the saphenous nerve are very liable to injury, for they lie quite superficially between the skin and the bone.

Most of the superficial veins of the front of the leg pass medially and upwards to terminate in the long saphenous vein; and as that vein ascends in front of the medial malleolus it receives tributaries from the medial side of the foot.

Cutaneous Nerves.—Branches of three nerves supply the skin of the front of the leg; branches of three nerves supply the dorsum of the foot; the dorsal surfaces of the toes are, for the main part, supplied by branches of three nerves; only one nerve is common to all three regions—the musculo-cutaneous.

The upper part of the front of the leg is supplied by the *infrapatellar branch of the saphenous nerve* (Fig. 102, p. 221).

The *lateral cutaneous nerve of the calf* (p. 280) is distributed to the skin between the infrapatellar region and the junction of the middle and distal thirds of the leg. The remainder of the front of the leg is supplied by the *musculo-cutaneous nerve.*

The medial side of the dorsum of the foot is supplied by the *saphenous nerve*, the lateral side by the *sural nerve*, and the intermediate area by the *musculo-cutaneous nerve.*

The adjacent sides of the first and second toes are supplied by the *medial division* of the *anterior tibial nerve*, the lateral sides of the little toe by the *sural nerve*, and all the remaining parts by branches of the *musculo-cutaneous nerve.*

The skin over the terminal phalanges of the first, second, third and the medial part of the fourth toes is supplied by branches of the *medial plantar nerve.*

The **musculo-cutaneous nerve** (superficial peroneal) is one of the two terminal branches of the lateral popliteal nerve. It begins on the lateral side of the neck of the fibula, descends between the muscles on the lateral side of the leg, and becomes cutaneous by piercing the deep fascia at the junction of the middle and distal thirds of the leg; it divides, either at once or shortly afterwards, into a medial and a lateral branch.

The *medial branch* supplies the medial part of the dorsum of the foot and divides into two branches, one of which is distributed to the medial side of the great toe, and the other to the adjacent sides of the second and third toes; it also gives a communicating twig to the anterior tibial nerve (Fig. 102). The *lateral branch* supplies the intermediate part of the dorsum of the foot, and also divides into two branches, one of which supplies the adjacent sides of the third and fourth toes, and the other, after receiving a twig from the sural nerve, supplies the adjacent sides of the fourth and fifth toes (Fig. 102). The branches of both divisions lie deep to the dorsal venous arch.

The **sural nerve** arises from the medial popliteal nerve,

descends over the gastrocnemius, pierces the deep fascia about halfway down the back of the leg, and is joined shortly afterwards by the sural communicating nerve (Fig. 114). It descends behind the lateral malleolus, and then, curving forwards below the malleolus, it runs along the lateral border of the foot to the little toe, giving branches, on its way, to the lateral part of the dorsum of the foot, and communicating with the musculo-cutaneous nerve. After it pierces the deep fascia, it lies alongside the short saphenous vein.

The account given above of the cutaneous nerves of the dorsum of the foot and toes indicates the general arrangement most often met with, but the dissector must be prepared to meet with many variations, especially on the lateral side, where the sural nerve and the lateral division of the musculo-cutaneous nerve not uncommonly replace each other to a greater or less extent.

Dissection. —After the cutaneous veins and nerves have been examined, remove the remains of the superficial fascia to display the deep fascia.

Deep Fascia. —The deep fascia does not form a complete investment for the leg. It is absent over the medial area of the tibia, and is attached to the anterior and medial borders of that bone. It is absent over the triangular subcutaneous surface of the fibula also, being attached to the borders of that area. It is not equally dense throughout. It becomes thinner towards the distal part of the leg until the region of the ankle is reached, where thickened bands are formed in it; and it becomes exceedingly thin and fine on the dorsum of the foot. Its great strength in the proximal part of the front of the leg is due to the fact that there it gives origin to fibres of the subjacent muscles. The bands in the region of the ankle are called *retinacula*, for they are formed to retain the tendons in position when the muscles which move the joint are in action. Four of the bands must be examined at this stage of the dissection, viz., the two extensor retinacula and the two peroneal retinacula.

The *superior extensor retinaculum* is a strong, broad band which stretches across the front of the leg from tibia to fibula, immediately above the ankle joint.

The *inferior extensor retinaculum* is distal to the ankle joint. Laterally, it is fixed firmly to the anterior part of the calcaneum. Medially, it divides into two diverging bands. The upper band is attached to the medial malleolus; the lower band passes to the medial side of the foot, and merges

into the deep fascia of the sole. The tendons that are strapped down by the extensor retinacula can be seen through the deep fascia as they emerge from under cover of the inferior retinaculum. From medial to lateral side they are—tibialis anterior, extensor hallucis longus, extensor digitorum longus and peroneus tertius (Figs. 142, 143).

The two muscles on the lateral side of the leg are called the *peroneus longus* and *peroneus brevis*. Their tendons descend over the back of the lateral malleolus, and then curve forwards below the malleolus. A thickened portion of the deep fascia straps them down on the back of the lateral malleolus, and is called the *superior peroneal retinaculum*. Another band—the *inferior peroneal retinaculum*—straps them down on the lateral surface of the calcaneum (Fig. 147).

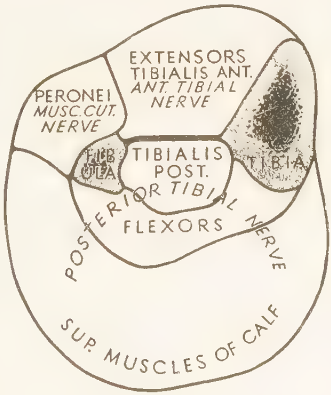


FIG. 141.—Diagram of the Osteo-fascial compartments of the Leg.

Intermuscular Septa (Fig. 141).—The deep fascia of the front and the lateral side of the leg sends in septa between the muscles. These septa give partial origin to the muscles; they are seen as white lines in the partially dissected limb, and their positions are indicated by narrow grooves in a thin living limb when the muscles are thrown into contraction.

Two of the septa are longer and stronger than the others, and are called the anterior and posterior intermuscular septa of the leg. The *anterior septum* separates the extensors on the front of the leg from the two peroneal muscles, and it is attached to the anterior border of the fibula. The *posterior septum* is interposed between the peroneal muscles and the muscles on the back of the leg, and is attached to the posterior border of the fibula. The leg is thus subdivided into three osteo-fascial compartments—anterior, lateral and posterior.

Dissection.—Remove the deep fascia from the front of the leg; but retain the extensor retinacula, separating them arti-

ficially, by the knife, from the deep fascia with which they are continuous. While thus defining their margins and while removing the deep fascia, take great care not to injure the synovial sheaths of the tendons that lie under cover of them. In the proximal part of the leg, it is impossible to raise the deep

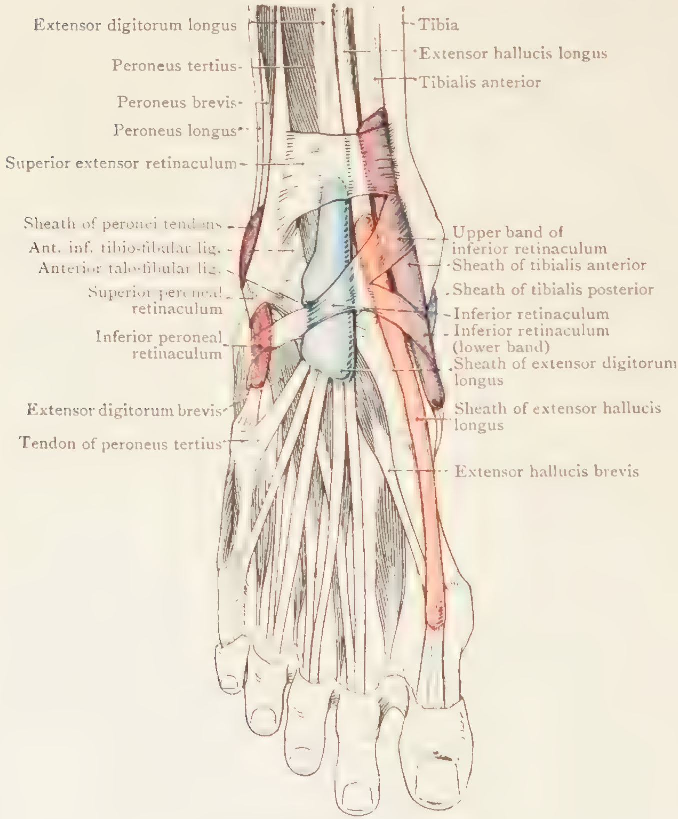


FIG. 142.—Synovial sheaths of the Dorsum of the Foot.

fascia from the muscles without lacerating their surfaces. It should, therefore, be left in position. At a lower level, it can readily be separated. Divide it in a longitudinal direction midway between the tibia and fibula. Turn the medial piece to the medial side, until its attachment to the anterior border of the tibia is demonstrated; then turn the lateral piece to the lateral side, until its continuity with the anterior intermuscular septum is displayed.

Now, attempt to distend the synovial sheaths of the tendons,

either by inflation with air through a blow-pipe, or by the injection of some liquid through a small syringe. Three sheaths are to be examined—the sheath of the tibialis anterior, the sheath of the extensor hallucis longus, and the sheath common to the extensor digitorum longus and the peroneus tertius (see Fig. 142, p. 316). Make a small incision through the deep fascia into each sheath in turn, either at the lower border of the inferior retinaculum or between its two bands, and insert the blow-pipe or the needle of the syringe. If inflation or injection fails, examine the extent of the sheaths with a blunt probe.

Synovial Sheaths on the Dorsum of the Foot.—There are three synovial sheaths in front of the ankle and on the dorsum of the foot—one around the tendon of the *tibialis anterior*, the second around the tendon of the *extensor hallucis longus*, and the third encloses the tendons of the *extensor digitorum longus* and the *peroneus tertius*.

The first extends from the upper border of the superior retinaculum to within a short distance of the insertion of the tibialis anterior into the medial cuneiform bone. The second begins behind the lower part of the superior retinaculum, and extends to the first phalanx of the big toe. The third extends from the lower border of the superior retinaculum to the middle of the dorsum of the foot. The sheaths facilitate the movements of the tendons when the muscles are in action; and they are of surgical importance because they are liable to become inflamed.

After the synovial sheaths have been examined, the anterior compartment of the leg may be investigated.

Contents of the Anterior Compartment of the Leg.—Four muscles are brought into view when the deep fascia of the front of the leg has been removed, viz., the tibialis anterior, the extensor digitorum longus, the extensor hallucis longus, and the peroneus tertius. The *tibialis anterior* lies in relation to the tibia; the *extensor digitorum longus* is placed along the fibula; and, when those muscles are separated from each other, the *extensor hallucis longus* will be seen in the interval between them. The *peroneus tertius* lies on the distal portion of the fibula, and is usually continuous with the extensor digitorum longus. The muscles arise partly from the bones of the leg, but to a large extent they take origin also from the deep fascia and the fascial septa.

The *anterior tibial vessels* and *nerve* descend in this compartment. At first they are deeply placed, but as they approach the ankle they come nearer to the surface.

FIG. 143.—Dissection of the Front and Lateral Side of Leg.

Dissection.—To expose the *anterior tibial vessels* and *nerve* in their entire course on the front of the leg, separate the tibialis anterior and the extensor digitorum longus from each other along the line of the strong intermuscular septum between them; carry the knife upwards along this septum. If the peroneus tertius muscle is drawn aside, the *perforating branch of the peroneal artery* will be seen piercing the interosseous membrane, and descending over the distal end of the fibula.

As you clean each structure in the front of the leg, follow it into the dorsum of the foot, and onwards to its termination, clearing away the deep fascia. The *dorsalis pedis* is the continuation of the anterior tibial artery into the foot. Clean it and its branches.

The small muscle on the dorsum of the foot is the *extensor digitorum brevis*. Clean it, and follow its tendons to the toes.

Tibialis Anterior.—This powerful muscle lies along the lateral side of the shin and takes origin chiefly from the upper half of the lateral surface

of the tibia, and from the interosseous membrane (Fig. 144). A strong tendon issues from its fleshy belly in the distal third of the leg, and reaches the dorsum of the foot by passing through both the extensor retinacula. On the foot, it inclines medially, and, turning round the medial margin, gains insertion into the medial side of the medial cuneiform bone near the sole, and into the adjoining part of the base of the first metatarsal bone. The tibialis anterior is supplied by the *anterior tibial nerve* and the *recurrent genicular nerve*. It is a dorsi-flexor and an invertor of the foot.

Extensor Digitorum Longus.—The extensor digitorum longus is a long, thin sheet of muscle which arises, for the most part, from the upper three-fourths of the anterior surface of the fibula (*i.e.* the narrow strip between the anterior and interosseous borders) (Figs. 143, 144). Its tendon descends in front of the ankle joint, and, passing behind the superior extensor retinaculum and through the inferior one (p. 314), divides into four slips, which diverge from one another to reach the lateral four toes, where they are inserted into the middle and distal phalanges. On the dorsum of the first phalanx of the *second*, *third* and *fourth* toes, each slip is joined, on its lateral side, by a tendon from the extensor digitorum brevis.

On those three toes, the tendons of the long and short extensors unite and form an expansion on the dorsum of the first phalanx. Each expansion, less well-defined than in the hand, divides into a central part and two collateral parts. The central part is slender and very short, and is inserted into the base of the middle phalanx; the stronger, collateral parts are prolonged forwards, and, after they have united together, they are inserted into the base of the terminal phalanx. The expansions are joined by thin extensions of slender tendons that pass obliquely upwards across the metatarso-phalangeal joints from certain muscles of the sole of the foot, namely the *lumbrical* muscles and the *interosseous* muscles—one lumbrical and two interossei to each expansion. Thus, five tendons gain insertion into the second and third phalanges of those three toes. The lumbrical and interosseous muscles flex the metatarso-phalangeal joint, and may aid the extensors in extending the interphalangeal joints.

The little toe has only one extensor tendon, but it expands,

divides and is inserted in the same way; it is joined by the tendons of one lumbrical and one interosseous muscle.

The extensor digitorum longus is supplied by the *anterior tibial nerve.* It is an extensor of the interphalangeal and metatarso-phalangeal joints of the lateral four toes and it dorsi-flexes the foot.

Peroneus Tertius.—This is a small muscle not always present; it is continuous at its origin with the extensor

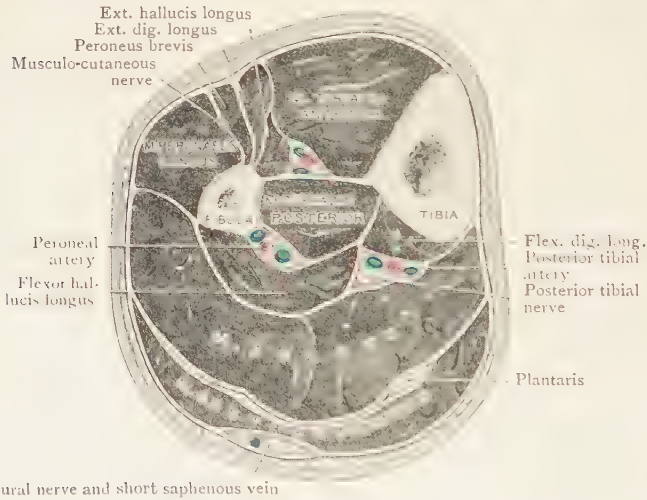


FIG. 144.—Transverse section through the Middle of the leg.

digitorum longus, of which it appears to be a separated part. It arises from the distal fourth of the anterior surface of the fibula, and from the interosseous membrane. Its slender tendon is inserted into the dorsal surface of the base of the fifth metatarsal bone. It is supplied by the *anterior tibial nerve.* It is a dorsi-flexor of the ankle joint and an evertor of the foot.

Extensor Hallucis Longus.—The long extensor of the big toe is a thin muscle placed between the tibialis anterior and the extensor digitorum longus. Its upper part is hidden by those muscles, but, near the ankle, it comes to the surface. It arises from the middle two-fourths of the anterior surface of the fibula, and also from the interosseous membrane. Its

tendon passes deep to the superior retinaculum, crosses in front of the distal part of the anterior tibial artery, and, descending in front of the ankle joint, it reaches the dorsum of the foot through the inferior retinaculum (Fig. 142). It then runs onwards to be inserted into the base of the distal phalanx of the big toe, occasionally giving a slip to the base of the proximal phalanx also. The extensor hallucis longus

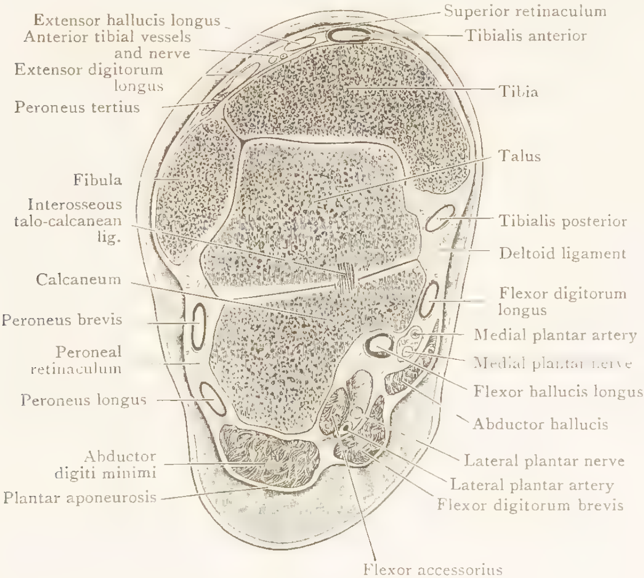


FIG. 145.—Coronal section through the Left Ankle Joint, Talus, and Calcaneum (Paterson).

is supplied by the *anterior tibial nerve*. It is an extensor of the phalanges of the big toe and a dorsi-flexor of the foot.

Anterior Tibial Nerve and Vessels.—The **anterior tibial nerve** (deep peroneal) is one of the two terminal branches of the lateral popliteal nerve. It arises on the lateral side of the neck of the fibula, under cover of the peroneus longus muscle, and, piercing the anterior intermuscular septum and the extensor digitorum longus, it enters the anterior compartment of the leg. In that compartment, it runs downwards to the ankle joint, which it crosses about

midway between the malleoli: and it ends on the dorsum of the foot, near the ankle joint, by dividing into a lateral and a medial branch.

In the upper two-thirds of the compartment, it lies very deeply, between the muscles, having the extensors digitorum longus and hallucis longus on its lateral side, and tibialis anterior medial to it ; but in the distal third, where the fleshy bellies give place to tendons, it is nearer the surface. At first, the nerve is in front of the interosseous membrane with the anterior tibial vessels on its medial side (Fig. 144) ; then it passes on to the front of the artery, which separates it from the interosseous membrane ; but, in the distal third of the leg, the nerve lies on the tibia with the vessels on one or other side of it—usually on its medial side again.

The extensor hallucis longus, at first on the lateral side of the nerve, crosses in front of the nerve and vessels just above the ankle to lie medial to them at the ankle, separating them from the tibialis anterior.

On the dorsum of the foot, the nerve lies on the talus, beneath the inferior extensor retinaculum, between the extensor digitorum longus and the dorsalis pedis vessels, which separate it from the extensor hallucis longus.

In its course through the leg the anterior tibial nerve gives *muscular branches* to the extensor digitorum longus, the tibialis anterior, the extensor hallucis longus, and the peroneus tertius ; and a fine *articular twig* to the ankle joint.

The *medial terminal branch* is continued forwards on the dorsum of the foot, lying under cover of the deep fascia, on the talus, the navicular, the middle cuneiform and the first dorsal interosseous muscle. The extensors digitorum longus and brevis are on its lateral side, but the tendon of the brevis for the big toe crosses it ; the extensor hallucis longus is on the medial side. The dorsalis pedis and first dorsal metatarsal artery are usually between it and extensor hallucis, but may be (as in Fig. 146) on the lateral side of the nerve.

At a variable point in the first interosseous space, it pierces the deep fascia, and divides to supply the contiguous margins of the big toe and the second toe (p. 312). Before it reaches the surface, it furnishes *articular twigs* to the tarso-metatarsal and metatarso-phalangeal joints of the big toe, and frequently, also, a fine *muscular twig* to the first dorsal interosseous muscle.

The *lateral terminal branch* of the anterior tibial nerve turns abruptly laterally, under cover of the extensor digitorum brevis, and ends on the dorsum of the tarsus in a gangliform enlargement. Branches proceed from the enlargement to supply the extensor digitorum brevis and the numerous joints in the neighbourhood. One fine filament can, in some cases, be traced to the second dorsal interosseous muscle.

The **anterior tibial artery** is the smaller of the two terminal branches of the popliteal. It takes origin in the back of the leg, at the distal border of the popliteus muscle, opposite the tubercle of the tibia (see Fig. 123). It enters the front of the leg by passing forwards through an opening in the upper part of the interosseous membrane. As it passes forwards, it lies close to the medial side of the neck of the fibula, and is found there in the present dissection. In the front of the leg it takes a straight course to the front of the ankle joint, midway between the malleoli, where it ends by becoming the *dorsalis pedis* artery.

It is closely accompanied by two *venæ comitantes* which are connected by cross branches that pass both behind it and in front of it. In the front of the leg, it accompanies the anterior tibial nerve. In the upper two-thirds, it is therefore deeply situated, on the front of the interosseous membrane, while, in the lower third, it lies on the tibia nearer the surface; and, at the ankle, it is crossed by the extensor hallucis longus.

The **branches** of the anterior tibial artery are:

1. Muscular.	4. Anterior recurrent.
2. Circumflex fibular.	5. Medial anterior malleolar.
3. Posterior recurrent.	6. Lateral anterior malleolar.

The *circumflex fibular* and *posterior recurrent branches* arise in the back of the leg, and will be seen in a subsequent dissection (p. 346).

The *muscular branches* are numerous, and come off at irregular points along the whole length of the artery.

The *anterior recurrent artery* is a small vessel which springs from the anterior tibial immediately after it reaches the front of the leg. It runs upwards through the tibialis anterior muscle, in company with the recurrent genicular nerve, to reach the front of the knee joint.

The *malleolar* branches are small arteries that take origin immediately above the ankle joint. They run under cover of the tendons, and ramify over the malleoli. The lateral one is the larger of the two.

Dorsalis Pedis Artery. This is the continuation of the anterior tibial. It begins on the front of the ankle joint; and, with its *venæ comitantes*, it runs forwards on the dorsum of the foot, alongside the anterior tibial nerve and its medial

terminal branch, as far as the proximal part of the first interosseous space. There, it leaves the dorsum of the foot, by dipping plantarwards, between the two heads of the first dorsal interosseous muscle, to end in the sole of the foot by uniting with the lateral plantar artery in the formation of the plantar arch.

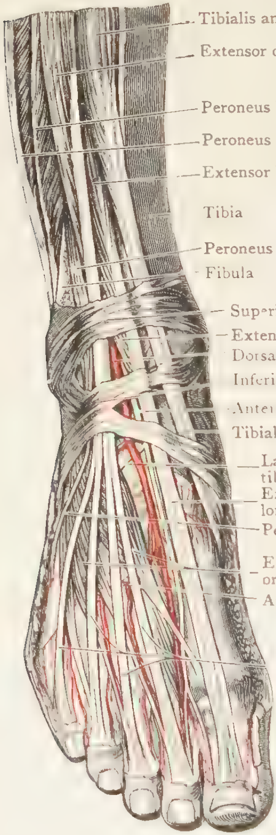


FIG. 146.—Dissection of the Dorsum of the Foot.

It is crossed, as it enters the dorsum of the foot, by the inferior extensor retinaculum, and, as it leaves the dorsum, by the extensor hallucis brevis.

On the dorsum of the foot, it gives off: — (1) *tarsal* arteries, (2) the *arcuate* artery, and (3) the *first dorsal metatarsal* artery. As it ends in the sole, it gives off— (4) the *first plantar metatarsal* artery, which will be examined when the sole is dissected.

The **tarsal arteries** are (*a*) small twigs to the medial side of the foot, and (*b*) a larger branch which arises opposite the navicular bone, and runs laterally under cover of the extensors.

The **arcuate artery** arises opposite the bases of the metatarsal bones, and runs laterally across them, under cover of the extensor tendons. It sends forwards *three dorsal metatarsal arteries* over the lateral three spaces, each of which divides into two *dorsal digital arteries* for contiguous sides of the toes, and the lateral one sends a twig to the lateral side of the little toe

The **first dorsal metatarsal artery** arises at the point where the dorsalis pedis dips towards the sole. It runs forwards over the first dorsal interosseous muscle, and divides into *dorsal digital branches* for the medial side of the big toe and the adjacent sides of the big toe and second toe.

Perforating Branch of Peroneal Artery.—This small artery arises in the back of the leg. It pierces the interosseous membrane an inch and a half or two inches above the lateral malleolus, and descends over the distal part of the fibula to anastomose with the lateral malleolar and tarsal arteries.

Extensor Digitorum Brevis.—The short extensor of the toes forms a fleshy cushion on the dorsum of the foot, and is supplied by the lateral branch of the *anterior tibial nerve*. It arises from the anterior part of the dorsal surface of the calcaneum, and also from the stem of the inferior extensor retinaculum. The muscular mass breaks up into four segments.

The most medial of the four is called the **extensor hallucis brevis**. It ends in a tendon which crosses the distal part of the dorsalis pedis artery, and is inserted into the base of the proximal phalanx of the big toe. It is an extensor of the first metatarso-phalangeal joint.

The remaining three segments end in tendons which join the long extensor tendons going to the second, third, and fourth toes, and, by means of the extensor expansion (see p. 319), they gain insertion into the middle and terminal phalanges of those toes. They act as extensors of the interphalangeal and metatarso-phalangeal joints.

Extensor Retinacula.—The dissector should now re-examine the extensor retinacula, and the arrangement of the structures which pass deep to them and through them. They are two thickenings of the deep fascia which strap down the tendons of the tibialis anterior, the peroneus tertius and the long extensors, and prevent them from springing away when the muscles contract. They are distinguishable from the adjoining deep fascia only by their greater thickness, and have to be artificially separated from it by dissection.

The **superior extensor retinaculum** (lig. transversum cruris) is a strong band, an inch or more in width from above downwards, situated immediately above the ankle joint. Its ends are firmly attached to the anterior borders of the tibia and the fibula. The long extensors, the peroneus tertius and the anterior tibial vessels and nerve pass behind it; but its medial part splits to enclose the tendon of the tibialis anterior

and its synovial sheath. To verify these points, divide the fibular attachment of the retinaculum, and pull it towards the tibial side.

The **inferior extensor retinaculum** (lig. cruciatum cruris) is the more important of the two. It is shaped like the letter Y placed on its side, and lies across the dorsum of the foot below and in front of the ankle joint. The stem of the Y is the lateral part of the ligament. It is firmly attached to the anterior part of the upper surface of the calcaneum. Its deep surface gives partial origin to the extensor digitorum brevis, and is connected with the strong, interosseous ligament that binds the calcaneum and the talus together. Traced medially, the stem divides into two diverging bands. The upper band inclines upwards to be attached to the anterior margin of the medial malleolus. The lower band passes to the medial side of the foot, and, blending with the deep fascia there, becomes indistinct, but may be traced into the deep fascia of the sole of the foot.

The deep surface of the retinaculum is adherent to the tarsal bones and ligaments, except where the dorsalis pedis vessels and anterior tibial nerves pass under cover of it ; but in three places it is split into two layers for the passage of tendons and their synovial sheaths (1) in the medial part of the stem, for the extensor digitorum longus and the peroneus tertius ; (2) in both arms of the Y, for the extensor hallucis longus ; and (3) more medially in both arms, for the tibialis anterior ; the layer that overlies the tibialis anterior is sometimes very thin.

Lateral Side of Leg

The following structures are enclosed in the lateral osteofascial compartment of the leg :—

1. Peroneus longus.
2. Peroneus brevis.
3. Termination of lateral popliteal nerve.
4. Musculo-cutaneous nerve.

Before the compartment is opened up, note the course of the tendons of the peroneus longus and brevis and examine their retinacula and their synovial sheath.

The tendons descend behind the lateral malleolus—the longus lying superficial to the brevis and are bound down by the thickened portion of the deep fascia called the superior

peroneal retinaculum. They then curve forwards, below the malleolus, over the lateral surface of the calcaneum and are held in contact with it by the inferior peroneal retinaculum. The peroneus brevis passes to its insertion into the base of the fifth metatarsal bone. The peroneus longus runs forwards below the brevis and is separated from the brevis by the peroneal tubercle when that process is present; and it disappears into the sole behind the base of the metatarsal bone.

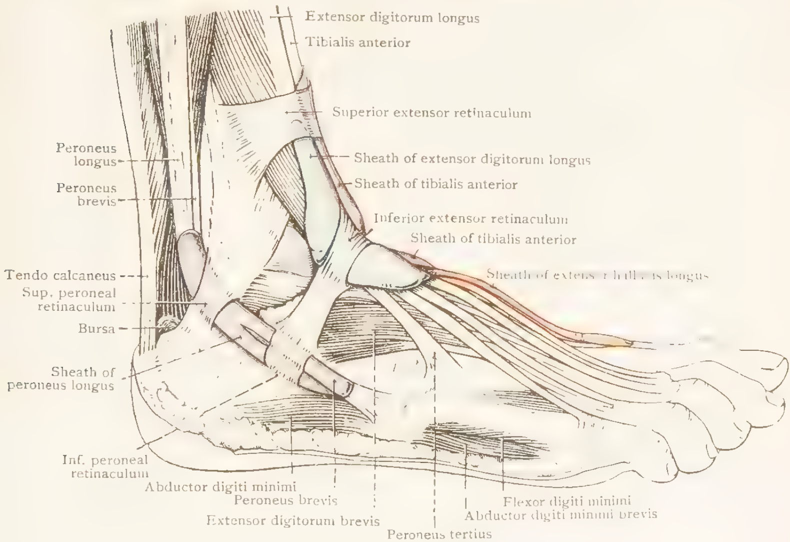


FIG. 147.—Dissection showing Synovial Sheath of Tendons of Foot.

The **synovial sheath** begins about two inches above the tip of the lateral malleolus, and is at first a single sheath that envelops both tendons; but on the lateral surface of the calcaneum it divides into two sheaths. The sheath of the peroneus brevis envelops it almost to its insertion. The sheath of the longus follows it across the sole to its insertion, but is often interrupted at the lateral side of the foot.

Dissection.—Identify the upper margin of the superior retinaculum. Remove the deep fascia immediately above it very carefully, and expose the *synovial sheath.* Pinch up the sheath and either inflate it or inject it in the way described on p. 317. If that fails, expose the peroneal tendons between the

two retinacula, and examine the extent and subdivisions of the sheath with a blunt probe. Then, clean the *retinacula*, and define their borders and connexions.

Peroneal Retinacula.—These bands are the thickened portions of the deep fascia that prevent displacement of the peroneal tendons. They are not so sharply marked off from the adjacent fascia as the extensor retinacula are, and require more careful dissection for their definition.

The **superior peroneal retinaculum** bridges over the peroneal tendons as they lie on the back of the lateral malleolus. It is attached to the margins of the posterior surface of the malleolus ; and, medially, it is connected also with the calcaneum and the layer of fascia that lies deeply in the back of the leg. It is lined with the common synovial sheath of the peronei.

The **inferior peroneal retinaculum** lies across the peroneal tendons when they reach the lateral surface of the calcaneum. Superiorly, it is attached to the anterior part of the upper surface of the calcaneum, and is continuous there with the stem of the inferior extensor retinaculum. Inferiorly, it is attached to the lateral surface of the calcaneum below the peroneal tendons. It sends in a septum which is attached to the calcaneum between the tendons ; each tendon, therefore, lies in a separate tunnel, which is lined with the branch of the synovial sheath that envelops the tendon.

Dissection.—Open up the lateral compartment of the leg to display its contents. Divide the deep fascia over the peroneal muscles by a longitudinal incision, and turn the flaps aside until their continuity with the intermuscular septa is demonstrated, but do not injure the peroneal retinacula.

Next, separate the two *peroneal muscles* from each other ; clean them, and secure their nerves of supply. Then, cut through the upper part of the peroneus longus in order to find the terminal part of the lateral popliteal nerve ; trace its *recurrent genicular branch* upwards, and the *musculo-cutaneous nerve* downwards.

Peroneal Muscles.—The peroneus longus and brevis are separated from the extensors by the anterior intermuscular septum and from the muscles of the calf by the posterior septum. The peroneus longus reaches up to the head of the fibula ; the peroneus brevis is in front of the longus, but reaches up only to the junction of middle and upper thirds of the fibula. They arise partly from the fibula, but most of their fibres spring from the intermuscular septa and the deep

fascia that covers them. They are evertors of the foot, and, to some extent, plantar-flexors; and they are supplied by the musculo-cutaneous nerve.

The **peroneus longus** muscle arises from the upper two-thirds of the lateral surface of the fibula. Its tendon begins a short distance above the ankle, descends behind the lateral malleolus, and then, curving forwards below the malleolus, it runs over the lateral surface of the calcaneum to the lateral border of the foot behind the base of the fifth metatarsal bone; there, it enters the groove on the plantar surface of the cuboid bone; in that groove, it runs obliquely across the sole of the foot to be inserted into the base of the first metatarsal bone and into the adjoining part of the medial cuneiform bone. Its position in the sole will be examined later.

The **peroneus brevis** muscle arises from the lower two-thirds of the lateral surface of the shaft of the fibula, overlapping the peroneus longus in the middle third. Its tendon descends over the back of the lateral malleolus, under cover of the peroneus longus, and then turns forwards, on the lateral surface of the calcaneum, above the longus, to gain insertion into the tuberosity on the base of the fifth metatarsal bone. Occasionally, it sends forwards a slender slip to join the extensor tendon of the little toe.

The **peroneus tertius** (p. 320), which acts with the other peroneal muscles in eversion of the foot, is a separated slip of the extensor digitorum longus.

Terminal Branches of Lateral Popliteal Nerve.—The lateral popliteal nerve has been traced as far as the neck of the fibula. At that point it disappears by passing forwards between the peroneus longus muscle and the bone. As it lies between them, it gives off a small *recurrent genicular branch* to the knee joint, and then divides into the *anterior tibial* and *musculo-cutaneous nerves*.

The *recurrent branch* pierces the extensor digitorum longus, and then accompanies the anterior tibial recurrent artery through the upper part of the tibialis anterior (which it supplies) to reach the capsule of the knee joint.

The *anterior tibial nerve* (deep peroneal) pierces the extensor digitorum longus to reach the anterior compartment of the leg, where it has already been dissected.

The **musculo-cutaneous nerve** (superficial peroneal) descends in the substance of the peroneus longus till it

reaches the peroneus brevis, and next, for a short distance, between the longus and brevis, and then, passing obliquely over the anterior border of the brevis, it descends, under cover of the deep fascia, in the groove between the peroneus brevis and the extensor digitorum longus. In the distal third of the leg, it pierces the deep fascia, and divides into a medial and a lateral branch, which descend into the foot (p. 313).

While in the substance of the peroneus longus, it gives branches to the peroneus longus and brevis. Its two terminal branches supply the skin of the lower part of the front of the leg, nearly the whole of the dorsum of the foot, and most of the toes.

Medial Side of Leg

This region corresponds to the subcutaneous or medial surface of the tibia, most of which is covered only with the skin and the superficial fascia, for the deep fascia blends with the periosteum at the borders of the bone—except in the upper part, where a thin layer of deep fascia covers the expanded tendons that overlie the bone, namely, sartorius, gracilis and semitendinosus.

The structures which have to be examined are :—

1. The long saphenous vein.
2. The saphenous nerve.
3. The tendons of insertion of the sartorius, gracilis, and semitendinosus.
4. The medial ligament of the knee joint.
5. The inferior medial genicular artery and nerve.

Dissection. The distal parts of the *long saphenous vein* and the *saphenous nerve* have already been cleaned. Now, trace them to the knee. Clean the *three tendons*, examine their attachments and throw them forwards ; examine the *bursæ* between them and under cover of them. The deeper bursa overlies the *medial ligament of the knee* ; and, as the bursa has probably been opened, the surface of the ligament is smooth and glistening. Clean the ligament from end to end ; define its borders ; and clean the *articular vessels* and *nerve* that pass under cover of it.

The *long saphenous vein* and the *saphenous nerve* will be studied later.

The insertions of the *sartorius*, *gracilis* and *semitendinosus* and their *bursæ* have been described already. Note again how the sartorius overlies the other two tendons, and how the tendon of the gracilis overlaps that of the semitendinosus.

The *medial ligament of the knee* is under cover of the sartorius, gracilis, and semitendinosus, and separated from them by a bursa. It is a long, strong band that stretches from the medial epicondyle of the femur to the shaft of the tibia some distance below its condyle. The tendon of the *semi-membranosus*, at its insertion into the tibial condyle, is partly under cover of the ligament; and the *inferior medial genicular vessels and nerve* pass forwards, under cover of the ligament, below the condyle, and turn upwards to the front of the knee.

Back of Leg

The structures met with in this dissection are :—

1. Saphenous veins.
2. Cutaneous nerves.
3. Deep fascia.
4. Flexor retinaculum.
5. Superficial muscles: Gastrocnemius. Plantaris. Soleus.
6. Tendo calcaneus and its bursa.
7. Posterior tibial vessels.
8. Posterior tibial nerve.
9. Deep muscles: Popliteus. Flexor hallucis longus. Tibialis posterior. Flexor digitorum longus.

Dissection.—Lay the limb on its anterior surface. Make the muscles of the calf tense by dorsi-flexing the foot, and keep it in that position by chains and hooks, fastened to the toes and to the under surface of the table.

Reflexion of Skin.—The skin has already been reflected from the front as far as the medial and lateral borders of the leg and foot. Now, make a transverse incision across the distal part of the heel and carry the extremities of the incision forwards along the medial and lateral borders of the foot; then remove the skin from the whole of the back of the leg, avoiding injury to the superficial veins and nerves.

Superficial Fascia.—The superficial fascia of the back of the leg presents no special or peculiar features; but it contains the following structures :—

- Superficial veins: Part of the long saphenous vein. Part of the short saphenous vein.
- Superficial lymph vessels.
- Cutaneous nerves:
  - Part of the saphenous nerve.
  - The terminal part of the posterior branch of the medial cutaneous nerve of the thigh.
  - The terminal part of the posterior cutaneous nerve of the thigh.
  - The sural nerve.
  - The sural communicating nerve.
  - The medial calcanean nerves.

Dissection.—The *long saphenous vein* and the *saphenous nerve* have already been traced down to the knee from the thigh, and up to the knee from the foot; clean the portions of them

that lie on the medial side of the knee, if that has not been done already.

The posterior branch of the *medial cutaneous nerve of the thigh* also was found. Trace it downwards over the medial part of the calf (Fig. 148); and trace the *posterior cutaneous nerve of the thigh* downwards over the middle of the calf.

The upper part of the *short saphenous vein* has been found in the popliteal fossa, and its lower part on the lateral border of the foot; now, clean the intervening part.

Find the *sural nerve* again, where it lies alongside the lower part of the short saphenous vein. Follow it upwards to the point where it pierces the deep fascia; then, trace it upwards to its origin from the medial popliteal nerve, incising the deep fascia to expose it. Two or three inches above the heel it is joined by the *sural communicating nerve*. Follow that nerve upwards to the point where it pierces the deep fascia, and then onwards to its origin from the lateral popliteal nerve.

Look for the *medial calcanean nerves* in the fascia at the medial side of the heel. They are small and difficult to find. The small arteries, if injected, are guides to them.

At this stage the dissector should revise the saphenous veins and the cutaneous nerves which have been seen in previous dissections, but are now, for the first time, displayed from beginning to end (Figs. 148, 149, 102, 114).

Saphenous Veins.—The long saphenous vein is the longest vein in the body. It commences at the medial border of the foot by the union of the dorsal venous arch with the medial digital vein of the big toe. It ascends in front of the medial malleolus, passes obliquely upwards and backwards across the medial surface of the distal third of the tibia, and then vertically upwards, along the medial border of the tibia, to the posterior part of the medial side of the knee. Thence, it passes obliquely upwards, forwards, and laterally, through the superficial fascia of the front of the thigh, to the saphenous opening, where it pierces the cribriform fascia and the femoral sheath and terminates in the femoral vein (Figs. 100, 102, 107).

Its named tributaries are the dorsal venous arch, the medial digital vein of the big toe, and three veins which it receives just before it pierces the cribriform fascia namely the superficial external pudendal, superficial epigastric, and superficial circumflex iliac (p. 217). But, during its course, it receives numerous unnamed tributaries. Further, it forms numerous communications with the deep veins of the limb by anastomosing channels which pierce the deep fascia.

The long saphenous vein is accompanied by several cutaneous nerves—from the saphenous opening to the middle

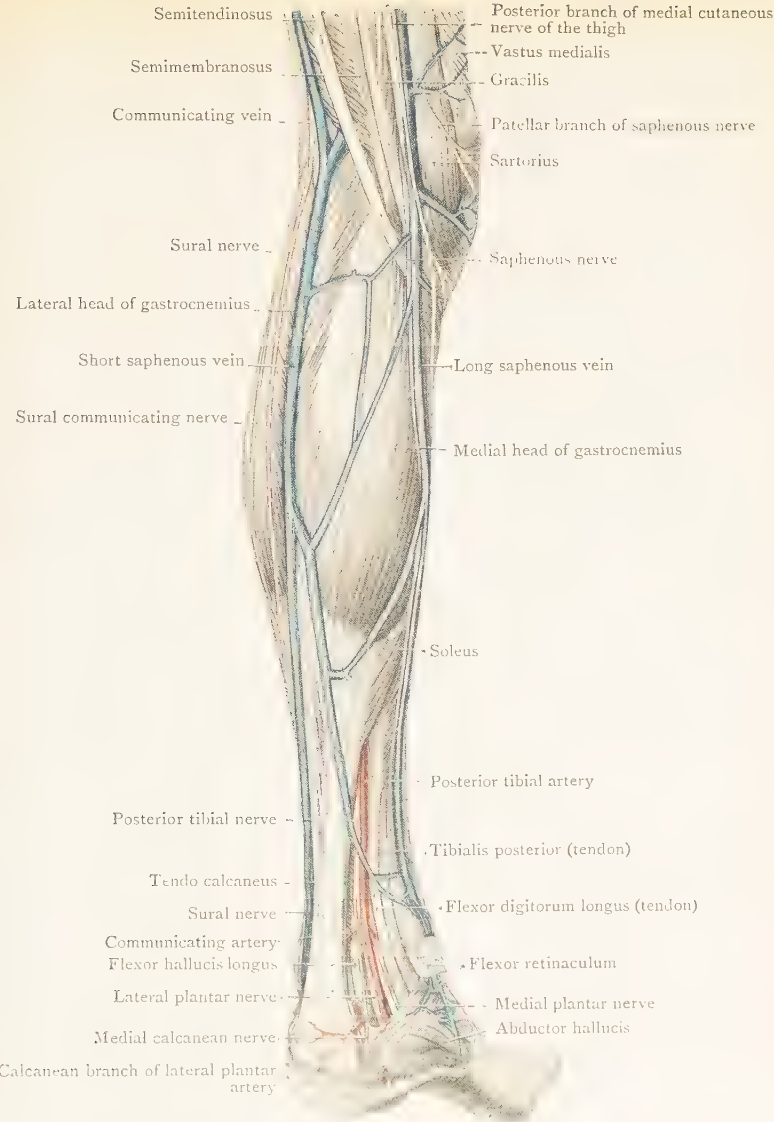


FIG. 148.—Dissection of the Leg viewed from the back and the medial side. Note the numerous anastomoses between the Long and the Short saphenous veins.

of the thigh, by branches of the medial cutaneous nerve of the thigh; from the middle of the thigh to the knee, by the anterior terminal branch of the medial cutaneous nerve of the thigh; and from the knee to the medial border of the foot, by the saphenous nerve.

It contains a number of valves; they partially divide the long column of blood into a series of segments, and so diminish the pressure on the walls of the more distal parts of the vein.

The **short saphenous vein** is formed, in the lateral border of the foot, by the union of the lateral digital vein of the little toe with the lateral end of the dorsal venous arch of the foot. From its point of commencement, it runs backwards below the lateral malleolus, and then upwards behind the lateral malleolus into the leg. There, it ascends a little lateral to the tendo calcaneus at first, and then along the middle line of the calf to the lower part of the popliteal region, where it pierces the popliteal fascia and terminates in the popliteal vein. Below and behind the lateral malleolus, it lies on the peroneal retinacula. From its commencement up to the middle of the calf, it lies alongside the sural nerve; above that it is alongside the posterior cutaneous nerve of the thigh, but the sural nerve, in this upper part, is separated from it only by the deep fascia.

The short saphenous vein receives tributaries from the lateral border of the foot, the heel, and the back of the calf.

The two saphenous veins are connected together by a fairly large vein which springs from the short saphenous vein, immediately before it pierces the deep fascia, and terminates in the long saphenous vein above the middle of the thigh. This vein sometimes forms the direct continuation of the short saphenous vein; and the short saphenous vein has then either only a very small connexion with the popliteal vein, or no connexion with it at all.

Cutaneous Nerves.—The **saphenous nerve** is the longest branch of the femoral nerve. It arises about an inch below the inguinal ligament, and descends, in the femoral triangle, along the lateral border of the femoral artery; it accompanies the artery through the adductor canal, lying first on its lateral side, then in front of it. It leaves the canal by passing behind the lower edge of its fibrous roof, accompanied by the saphenous branch of the descending genicular artery, and then lies directly under cover of the sartorius. It escapes from

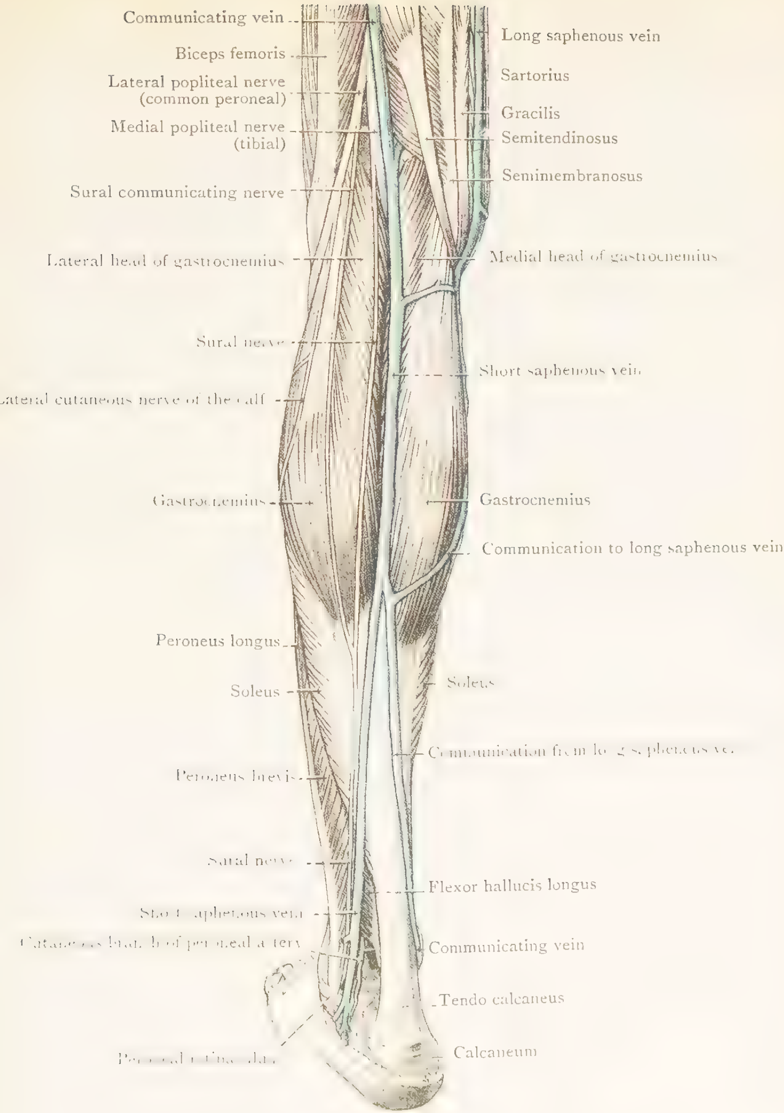


FIG. 149.—Dissection of the Leg viewed from the back and the lateral side.

In the specimen there were numerous large anastomosing channels between the short and the long saphenous vein.

under cover of the sartorius at the posterior border of the muscle—between the sartorius and the tendon of the gracilis – a little above the knee. It then descends along the posterior part of the medial side of the knee, where it pierces the deep fascia and enters the leg. In the leg, it accompanies the saphenous vein (lying usually behind the vein) first along the medial border of the tibia, and then obliquely forwards across the distal third of the tibia. It enters the foot by passing downwards in front of the medial malleolus — still in company with the vein —and it ends in the skin at the middle of the medial border of the foot. In the adductor canal it gives twigs to the subsartorial plexus and thence to the skin of the thigh. After it leaves the canal, and before it emerges between the sartorius and gracilis, it gives off an *infrapatellar branch*, which pierces the sartorius on its way to the patellar plexus. Beyond the knee, its branches are distributed to the skin of the medial side of the leg and foot.

FIG. 150.—Cutaneous Nerves on the back of the Lower Limb.

The **sural nerve** arises in the popliteal fossa from the medial popliteal nerve, descends in the groove between the two heads of the gastro-

cnemius, pierces the deep fascia of the leg, about midway between the knee and the ankle, and accompanies the short saphenous vein into the foot—descending to the back of the lateral malleolus in front of the vein or lateral to it, and then forwards along the lateral border of the foot above the vein, and onwards to the end of the little toe.

Shortly after it pierces the deep fascia, it is joined by the sural communicating nerve ; on the side of the foot it gives a communicating twig to the branch of the musculo-cutaneous nerve destined for the contiguous sides of the fourth and fifth toes. It supplies the skin of the lower, lateral part of the back of the leg, the lateral border of the foot and adjoining part of the dorsum, and the lateral side of the little toe.

The **sural communicating nerve** (anastomotic peroneal) arises in the popliteal fossa from the lateral popliteal nerve (common peroneal), crosses superficial to the lateral head of the gastrocnemius, where, as a rule, it pierces the deep fascia ; it then passes downwards and medially to the upper end of the lateral border of the tendo calcaneus, where it joins the sural nerve. It supplies the skin of the proximal two-thirds of the posterior surface of the calf.

The **medial cutaneous nerve of the thigh** is a branch of the femoral nerve. It runs downwards and medially across the femoral artery, and divides, at the apex of the femoral triangle into two branches. The *anterior branch* is distributed to the skin of the lower part of the medial side of the thigh (pp. 221, 242). The *posterior branch* runs downwards along the medial or posterior border of the sartorius, pierces the deep fascia a little above the knee, behind the sartorius and the long saphenous vein, and descends to supply the skin of the upper part of the medial side of the leg.

The *posterior cutaneous nerve of the thigh*, and the *lateral cutaneous nerve of the calf* have already been sufficiently described (see pp. 263, 278, 280, 313).

The Lymph Vessels and Lymph Glands of the Lower Limb.—In an ordinary dissecting-room subject, it is impossible to display the lymph vessels of the limb in a satisfactory manner. The dissector will have seen the inguinal lymph glands, and may have found one or two of the popliteal group, but he will not have been able to trace the lymph vessels except for a short distance as they enter and leave the glands in the groin. He should, however, at this point, study the general arrangement of the lymph glands and vessels of the limb.

As in other parts of the body, there are superficial and deep groups of both glands and vessels.

The **superficial lymph glands** are the superficial inguinal glands, and they are in two groups—upper and lower (p. 217).

The **deep lymph glands** are related to the main blood-vessels. They are:—The deep inguinal glands (p. 234), the popliteal glands (p. 276), and a single anterior tibial gland which lies close to the anterior tibial artery in the upper part of the front of the leg.

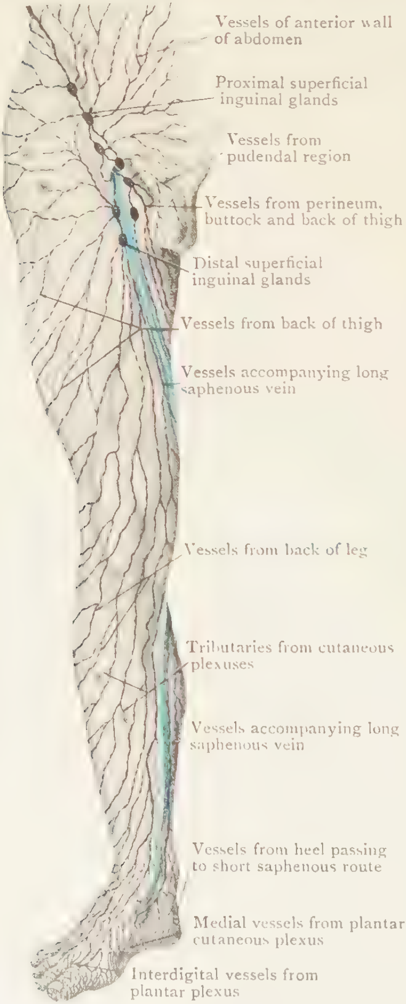


FIG. 151.—The Superficial Lymph Vessels of the front of the Lower Limb.

The **deep lymph vessels** are much less numerous than the superficial vessels, though they drain all the structures that lie deep to the deep fascia. They run along the principal blood-vessels, and most of them end in the deep inguinal glands — the exception being those from the deep parts of the gluteal region and upper part of back of thigh, which accompany the gluteal vessels into the pelvis and end in the internal iliac glands. Those from the leg are interrupted in the popliteal glands; and the anterior tibial gland is placed in the path of those that run along the anterior tibial vessels.

The **superficial lymph vessels** collect the lymph from the skin and the subcutaneous tissues. They all ultimately reach the deep inguinal lymph glands; and their paths are determined by their tendency to converge upon two main streams. Thus: far more of the vessels of the foot ascend in front of the ankle than behind it, and most of them—and many others from the leg and thigh—converge upon the long saphenous vein, and follow it to the superficial inguinal glands; the remainder —a small number from a relatively limited area

of foot and leg—follow the short saphenous vein to the popliteal glands.

In the sole of the foot, as in the palm of the hand, there is a dense cutaneous plexus of lymph capillaries, and the origin of the lymph vessels from the plexus resembles that of the hand (p. 77); but the great projection of the heel causes a slightly different orientation of the vessels as they leave the foot. The vessels from the lateral border of the foot, from the back of the heel, and from part of the back of the leg (Fig. 152) accompany the short saphenous vein to the popliteal glands. The vessels from the distal parts of the plantar surfaces of the toes pass to the dorsum of the foot at the interdigital clefts. Then, together with vessels that arise from the plantar capillary plexus, and from the dorsum and medial border of the foot, they ascend across the front of the ankle and the medial malleolus, and constitute the main stream along the line of the long saphenous vein. They are joined by vessels from the front and medial side of the leg, and from the medial side and greater part of the front of the thigh; and all these vessels end in the lower group of inguinal glands. The vessels from the upper part of the front of the thigh, the back of the thigh and the gluteal region converge upon the upper group of inguinal glands, to which vessels proceed also from the perineum and the lower part of the anterior wall of the abdomen. The efferents from these glands pass to the deep inguinal glands.

It follows from what has been said that, with the exception of the lymph from the deep parts of the gluteal region and back of thigh, all the lymph of the lower limb passes through the deep inguinal glands; and it may be noted,

FIG. 152.—The Superficial Lymph Vessels of the back of the Lower Limb.

further, that the efferent vessels from these glands pass to the external iliac glands in the abdomen immediately above the inguinal ligament, whence the lymph is carried onwards, through the common iliac and aortic glands to the lumbar lymph trunks.

The student should compare the arrangement of the lymph vessels of the Lower and Upper Limbs (p. 76). He should note, in particular, the manner in which the superficial lymph vessels of each limb converge upon the important groups of lymph glands at the roots of the limbs (armpit and groin), and that these groups receive also the superficial vessels of the trunk, and thus share a very wide territory between them.

Dissection. **Remove the remains of the superficial fascia from the back of the leg, and clean the deep fascia.**

Deep Fascia.—In the proximal part of the calf, the deep fascia is thin and transparent ; it thickens considerably as the heel is approached. On the lateral side of the ankle, it is thickened to form the *superior peroneal retinaculum* (p. 328). On the medial side, it is greatly strengthened to form a broad band which bridges across the interval between the calcaneum and the medial malleolus, and is called the *flexor retinaculum* (lig. laciniatum) because it straps down the tendons of the long flexors of the toes and the tibialis posterior and retains them in place as they pass from the back of the leg into the foot.

The deep fascia is continuous proximally with the popliteal fascia, and, a short distance below the knee, on the medial side, it receives reinforcements of fibres from the tendons of the sartorius, gracilis, and semitendinosus. On the medial side, the deep fascia is attached to the medial border of the tibia, where it blends with the periosteum, and on the lateral side it joins the posterior intermuscular septum, by which it is attached to the posterior border of the fibula (Figs. 141, 144). Thus, it forms the posterior boundary of the great posterior osteó-fascial compartment of the leg.

Posterior Osteo-fascial Compartment of Leg. This compartment is bounded *posteriorly and at the sides* by the investing deep fascia, and *anteriorly* by the tibia, the interosseous membrane, the fibula and the posterior intermuscular septum (Fig. 141). Two strong fascial septa stretch across the compartment and divide it into three sections, whose contents are the following :—

Posterior section.	Gastrocnemius.	Superficial muscles of calf.
	Plantaris.	
	Soleus.	
	Tendo calcaneus, *i.e.* the common tendon of gastrocnemius and soleus.	
	A mass of fat in front of tendo calcaneus.	
	Sural nerve.	

Anterior section.	Tibialis posterior.	Deep muscles of calf.
Middle section.	Flexor digitorum longus. Flexor hallucis longus. Posterior tibial artery and its branches, including peroneal artery and its branches. Corresponding veins. Posterior tibial nerve and its branches.	

The **first septum** or posterior septum is a fairly thick fascial membrane that extends across from the medial border of the tibia to the posterior border of the fibula, and covers the long flexors of the toes and the posterior tibial vessels (Fig. 144).

Inferiorly, it has important connexions. In the middle, it is connected merely with the deeper part of the fibro-fatty tissue that underlies the tendo calcaneus ; on the lateral side, it helps the investing fascia to form the superior peroneal retinaculum ; and, on the medial side, it is continued into the flexor retinaculum and constitutes the greater part of its thickness.

Superiorly, it is attached to the soleal line of the tibia and to the back of the fibula below the origin of the soleus muscle. Between those attachments, it is continuous with the fascia of the popliteus muscle ; at that level, it is pierced by the popliteal vessels, and below that level it is thickened to form a fibrous arch over the terminal part of the popliteal vessels and the proximal part of the tibial vessels. That arch gives partial origin to the soleus muscle.

The **second septum** covers the tibialis posterior,. It is attached, medially, to the proximal part of the soleal line of the tibia and to the vertical ridge on the posterior surface of the tibia, and, laterally, to the medial crest of the fibula. Above, it blends with the interosseous membrane ; inferiorly, it fuses with the deep surface of the first septum in the distal part of the leg.

The dissector will now proceed to expose the contents of the three sections of the posterior osteo-fascial compartment, beginning with the superficial section.

Dissection.—First, clean the flexor retinaculum carefully, and secure the *medial calcanean arteries* and *nerves*, which pierce it. Note that it is continuous proximally with the deep fascia of the back of the leg, and that distally it gives attachment to a muscle called the abductor hallucis. Then, make a longitudinal incision through the deep fascia, down the middle of the back of the leg, from the popliteal region to the calcaneum. Turn the two flaps to the sides, detaching their distal parts from the retinacula.

Next, clean the gastrocnemius and the tendo calcaneus ; and

remove the thick pad of fat which lies in front of the tendo calcaneus and separates it from the first fascial septum. Examine the distal portion of that septum and note the important part it plays in binding down the muscles of the middle section of the compartment, and in the formation of the retinacula.

If the medial head of the gastrocnemius was not divided when the popliteal fossa was dissected, divide it now, at the level of the knee joint, and turn it laterally; then clean the lower muscular branches of the popliteal artery, and the nerves which supply the gastrocnemius.

Raise the proximal part of the divided muscle, and note the bursa which intervenes between it and the semimembranosus.

Next, follow the nerve to the soleus, which was found when the popliteal fossa was dissected (see p. 278). Lastly, clean the plantaris, and follow its slender tendon to its insertion.

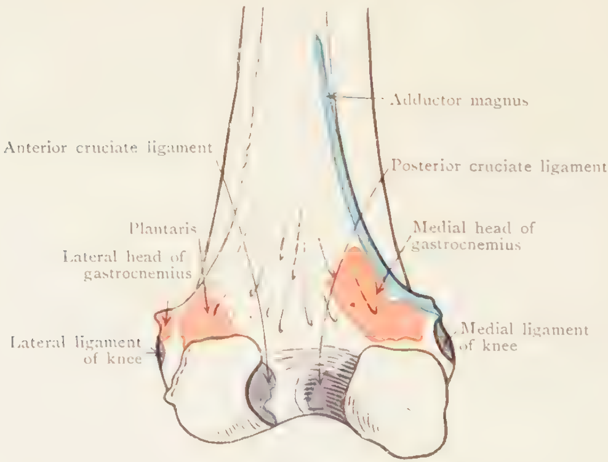


FIG. 153.—Distal part of Back of Femur, with Attachments of Muscles mapped out.

Superficial Muscles. The superficial muscles of the calf of the leg are three in number, viz., the gastrocnemius, the plantaris, and the soleus. The gastrocnemius is the most superficial; the soleus is placed under cover of the gastrocnemius; whilst the slender plantaris runs downwards and medially between them. The tendons of the gastrocnemius and soleus unite to form the tendo calcaneus.

The **gastrocnemius** is a strong muscle. It arises from the distal end of the femur by two heads; they have already been studied in relation to the popliteal fossa, which

they bound in its distal part. The *lateral head* springs from an impression on the lateral surface of the lateral condyle of the femur. The *medial head* takes origin from a rough, raised area on the popliteal surface of the femur above the medial condyle.

The two fleshy bellies swell out as they descend, and they end, near the middle of the leg, in a thin, aponeurotic tendon. They do not blend with each other, and are usually separated by a furrow, at the bottom of which the flattened tendon, to which the fasciculi of both heads are attached, may be seen. The medial head is bulkier than the lateral head, and extends farther down; it is separated from the back of the capsule of the knee joint by a *bursa* which may communicate with the cavity of the joint and with the semimembranosus bursa. The lateral head often contains a small sesamoid bone, (the 'fabella'), opposite the lateral condyle (Figs. 175, 177 B); and, occasionally, it is separated by a bursa from the capsule of the knee joint. The flattened tendon in which the heads terminate narrows slightly as it descends, and, a short distance below the middle of the leg, it blends with the tendon of the soleus to form the tendo calcaneus.

The gastrocnemius is supplied by the *medial popliteal nerve*. It is a plantar flexor of the foot and a flexor of the knee, but it cannot act efficiently both on the knee and the ankle joint at the same time. Thus, if the foot is plantar-flexed it cannot flex the knee, and if the knee is flexed it cannot act upon the ankle. It is important to remember these facts in association with fractures of the distal part of the femur.

The **plantaris** has a small, fleshy belly—not more than three or four inches long. It lies along the medial side of the lateral head of the gastrocnemius and partly under cover of it. It arises from the popliteal surface of the femur, above the lateral condyle. It ends in a slender tendon which is remarkable for its great length. The tendon proceeds downwards and medially, between the gastrocnemius and soleus, and then runs along the medial side of the tendo calcaneus to gain insertion into the calcaneum. It is frequently closely connected with the tendo calcaneus, and sometimes becomes blended with it, or with the fascia of the leg.

The plantaris is supplied by a branch from the *medial popliteal nerve*. It is associated in its action with the gastro-

cnemius; and its chief importance is that its tendon is sometimes ruptured during violent exercise. It is occasionally absent.

Dissection. Divide the lateral head of the gastrocnemius at the level of the knee joint. Turn the proximal part upwards, and examine it to see if it contains a sesamoid bone; then look for a bursa which is occasionally present between it and the capsule of the knee joint. Turn the distal part downwards and note the manner in which the two heads join the aponeurotic tendon, and the union of the tendon with the tendon of the soleus.

Now, clean the posterior surface of the soleus, and define its origin. Note that some of its fibres pass directly to the deep surface of the tendo calcaneus.

The **soleus** is a flat, thick, and powerful muscle which arises from both bones of the leg, as well as from a strong fibrous arch which is thrown across the popliteal vessels. Its *fibular origin* is from the back of the head and the upper third of the posterior surface of the shaft; by its *tibial origin* it is attached to the soleal line and the middle third of the medial border of the tibia (Fig. 155, p. 348). The soleus ends in a strong, stout tendon which joins with the tendon of the gastrocnemius to form the tendo calcaneus. Branches enter the soleus on its superficial surface at its upper end from the *medial popliteal nerve*, and on its deep surface from the *posterior tibial nerve*. It is a plantar-flexor of the foot.

Tendo Calcaneus. This is the most powerful tendon in the body. It narrows as it descends, but near the heel it again expands slightly to be inserted into the middle portion of the posterior surface of the calcaneum. The fleshy fibres of the soleus are continued downwards on its deep surface almost to the heel. A small bursa separates the tendon from the upper part of the posterior surface of the calcaneum; and, above that, an ill-defined synovial sheath is sometimes found superficial to the tendon.

Dissection. Divide the soleus muscle along its line of origin from the tibia and separate it from the fibrous arch over the vessels. Turn it laterally; sever the arteries which enter it, but secure and preserve its nerve from the posterior tibial nerve.

The *first fascial septum* of the back of the leg is now fully exposed. Note its connexions (see p. 341). Separate it carefully from the flexor and peroneal retinacula; then divide it longitudinally along the middle line of the leg, and turn the two pieces to the sides.

The middle section of the posterior osteo-fascial compartment is now opened up, and its contents are exposed—the

vessels and the nerve being embedded in some loose areolar tissue. The muscle on the medial side is the *flexor digitorum longus*; the muscle on the lateral side is the *flexor hallucis longus*. In the distal part of the leg, the tendon of the *tibialis posterior* will be seen emerging from under cover of the medial border of the tendon of the flexor digitorum.

Dissection.—Clean the *posterior tibial nerve* and secure its muscular branches; they arise as a rule in the upper part of the leg. Next, clean the termination of the *popliteal artery*, the first part of the *anterior tibial artery* and its branches; then the *posterior tibial vessels* and their branches and tributaries. The *peroneal branch* of the posterior tibial artery arises about one inch below the commencement of the parent trunk. It soon disappears under cover of the flexor hallucis longus; do not trace it at present beyond the point of disappearance.

Now, clean the flexors of the toes. Then, separate the two muscles and push the flexor hallucis longus laterally, separating its deep surface from the second fascial septum and from the distal part of the interosseous membrane. As the fibula is approached, the peroneal artery will be found descending between the flexor hallucis longus and the second fascial septum. Trace the artery downwards. Immediately above the inferior tibio-fibular joint, it gives off its perforating branch. Now, pull the distal part of the flexor hallucis longus medially and follow the peroneal artery along the medial side of the peronei tendons to the lateral side of the calcaneum. In order to expose its terminal branches, divide the peroneal retinacula, and, if necessary, displace the peroneal tendons.

Posterior Tibial Nerve.—This nerve is the continuation of the medial popliteal (N. tibialis). It begins at the lower border of the popliteus, and descends through the back of the leg, under cover of the first fascial septum, to end about midway between the calcaneum and the medial malleolus, under cover of the flexor retinaculum, by dividing into the lateral and medial plantar nerves.

From above downwards, it rests on the fascia of the tibialis posterior, the flexor digitorum longus, the lower end of the tibia and the back of the ankle joint. In its upper two-thirds, it is situated deeply, being covered by the superficial muscles of the calf. In the distal part of the leg, where it lies about midway between the tendo calcaneus and the medial border of the tibia, it is near the surface, being separated from the superficial fascia merely by the investing layer of the deep fascia and by the first fascial septum; and at its termination it is under cover of the flexor retinaculum—which is the thickened, fused part of those two fascial layers.

The posterior tibial vessels are at first on its lateral side;

but an inch below the popliteus (at the origin of the peroneal artery) the vessels cross in front of the nerve, and thereafter lie along its medial side.

Its **branches** are muscular, cutaneous and articular.

The *muscular* branches arise in the upper part of the leg. They supply the tibialis posterior, flexor hallucis longus, flexor digitorum longus and the deeper part of the soleus.

The *cutaneous* branches spring from the lowest part of the nerve. They are the *medial calcanean nerves*, which pierce the flexor retinaculum (lig. laciniatum) and supply the skin of the posterior and lower surfaces of the heel.

The *articular* branches are small twigs that arise from the lowest part of the nerve and supply the posterior part of the capsule of the ankle joint.

Termination of the Popliteal Artery.—The terminal part of the popliteal artery, which was concealed by the upper border of the soleus, is now fully exposed. It ends at the distal border of the popliteus, where it divides into two branches—the anterior and posterior tibial arteries. At the same point, the *venæ comitantes* of those arteries join together to form the popliteal vein.

The **anterior tibial artery** passes forwards, through the bifid upper end of the tibialis posterior muscle, to the front of the leg. While still in the back of the leg, it gives off a posterior recurrent tibial and a circumflex fibular branch.

The *posterior tibial recurrent* is a small twig which is not always present. It runs upwards, under cover of the popliteus muscle, to the back of the knee joint. The *circumflex fibular branch* runs laterally, round the neck of the fibula, and is distributed to the muscles and skin in that neighbourhood.

Posterior Tibial Artery.—This is the larger of the two terminal branches of the popliteal trunk. It takes origin at the distal border of the popliteus muscle, and, passing downwards and slightly medially, in company with the posterior tibial nerve, to the hollow between the medial malleolus and the calcaneum, it ends by dividing into the lateral and medial plantar arteries, under cover of the flexor retinaculum, at a slightly lower level than the division of the nerve.

It is closely accompanied by two *venæ comitantes*, which are connected with each other by small veins that cross in front of the artery and behind it; and it has the same general relations as the nerve.

The following branches arise from it :—

1. Muscular.
2. Cutaneous.
3. Nutrient to tibia.
4. Peroneal.
5. Medial calcanean.
6. Communicating branch.
7. Medial plantar.
8. Lateral plantar.

FIG. 154.—Deep Dissection of Back of Leg.

The *nutrient artery* springs from the posterior tibial close to its origin, and, after giving some twigs to muscles, enters the nutrient foramen of the tibia. It is remarkable on account of its large size.

The *muscular branches* supply the deep muscles on the back of the leg, and one or two of large size enter the soleus.

The *cutaneous branches* are given to the skin on the medial side of the leg.

The *communicating branch* is given off about an inch above the distal end of the tibia. It passes transversely laterally, under cover of the flexor hallucis longus or superficial to it, and joins the peroneal artery (Figs. 148, 149, 154).

The *medial calcanean branches* pierce the flexor retinaculum, and accompany the nerves of the same name.

The **peroneal artery** is not the first branch of the posterior tibial, but it is, as a rule, the largest branch. It arises about an

inch below the commencement of the parent trunk, and at first runs obliquely downwards and laterally, under cover of the soleus, to reach the fibula, and then descends along the fibula, in front of the flexor hallucis longus. Immediately above the ankle joint, it emerges from under cover of the flexor hallucis longus, passes behind the inferior tibio-fibular joint and the ankle joint, medial to the peroneal tendons, and breaks up into a number of lateral calcanean branches.

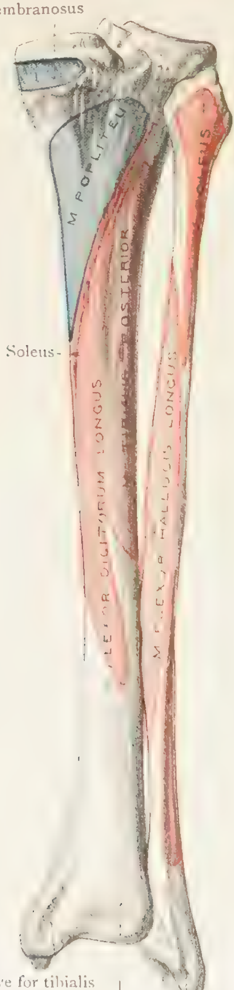


FIG. 155. — Posterior aspect of Bones of Leg with Attachments of Muscles mapped out.

The **branches** of the peroneal artery are: (1) *muscular* branches; (2) a *nutrient* branch to the fibula; (3) the *perforating* branch which pierces the interosseous membrane near the inferior tibio-fibular joint, and descends over the lower part of the fibula into the dorsum of the foot; (4) the terminal *lateral calcanean* branches ramify on the lateral surface of the calcaneum.

The peroneal artery is sometimes as large as the continuation of its parent trunk. In such cases the perforating branch may be large, and may partially or entirely replace the dorsalis pedis artery, or its communication with the posterior tibial artery may be large.

Deep Muscles. — The tendon of origin of the *popliteus muscle* is inside the knee and cannot be seen till the joint is dissected, but its fleshy part will be seen lying on the back of the tibia above the soleal line.

Note the strong fascia which covers the posterior surface of the popliteus, and trace it upwards and medially to the medial side of the

knee. There it becomes continuous with the tendon of the semimembranosus, and through it, therefore, the semimembranosus may be regarded as having an insertion into the soleal line of the tibia.

The *flexor hallucis longus* lies on the back of the fibula, and its tendon will be noticed grooving the posterior border of the talus as it passes downwards and forwards to gain the sole of the foot. The *flexor digitorum longus* lies on the tibia. The *tibialis posterior* rests on the interosseous membrane and between the fleshy bellies of the two flexors but upon a deeper plane. These muscles arise from the fascial septa and the interosseous membrane, as well as from the bones of the leg.

The **popliteus** muscle arises by a stout, round tendon, within the capsule of the knee joint, from the anterior part of the popliteal groove of the femur. The tendon pierces the posterior part of the capsule of the knee joint, and the fleshy fibres which arise from the tendon are directed medially and downwards, and spread out to obtain insertion into the posterior surface of the tibia above the soleal line, and also into the fascia which covers the muscle.

Its nerve has already been seen to arise from the *medial popliteal nerve*. It can now be seen hooking round the distal margin of the muscle to reach the anterior surface. The popliteus is a flexor of the knee and a medial rotator of the leg at the beginning of the movement of flexion.

The **flexor hallucis longus** muscle arises chiefly from the posterior surface of the fibula, below the origin of the soleus. After passing behind the ankle joint, its tendon occupies a deep groove on the posterior border of the talus ; it then turns forwards under cover of the flexor retinaculum to gain the sole of the foot, where it runs forwards to be inserted into the terminal phalanx of the big toe.

The flexor hallucis longus is supplied by the *posterior tibial nerve*. It is a flexor of the interphalangeal and metatarso-phalangeal joints of the big toe, a plantar-flexor of the foot, and it assists in producing inversion of the foot.

The **flexor digitorum longus** arises from the posterior surface of the tibia, below the popliteus, and medial to the vertical ridge. After crossing superficial to the distal part of the tibialis posterior, its tendon grooves the lower end of the tibia on the lateral side of the tendon of the tibialis posterior. It is continued under cover of the flexor retinaculum into the sole of the foot, where it divides into four

tendons for the lateral four toes, and each tendon is inserted into the terminal phalanx of its toe.

It is supplied by the *posterior tibial nerve*. It is a flexor of the interphalangeal and metatarso-phalangeal joints of the lateral four toes, and it assists in producing plantar flexion and inversion of the foot.

The **tibialis posterior** takes origin from the interosseous

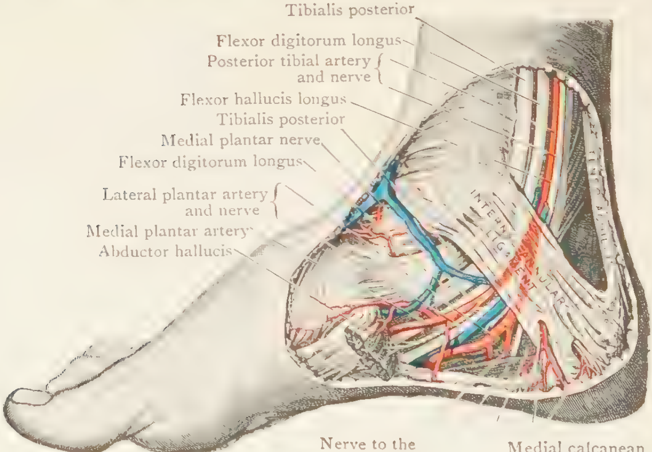


FIG. 156.—Dissection of the medial side of the Ankle, showing the relations of the flexor retinaculum (lig. laciniatum ; "internal annular ligament").

membrane and the adjoining parts of the posterior surfaces of the tibia and fibula. Its attachment to the interosseous membrane does not reach so high as the attachments to the bones. The upper end of the muscle is therefore bifid ; and the anterior tibial vessels pierce the interosseous membrane between the two parts. In Figs. 141, 144, the compartment which it occupies is shown in a diagrammatic manner, and the surfaces from which it takes origin are indicated. Towards the distal part of the leg, the tibialis posterior inclines medially, under cover of the flexor digitorum longus, and its strong, flattened tendon grooves the back of the medial malleolus at the medial side of the tendon of that muscle. Proceeding under cover of the flexor retinaculum, its tendon is inserted

into the tuberosity of the navicular bone, and also, by a number of slips, into nearly all the tarsal and metatarsal bones. Those slips will be dissected later.

The tibialis posterior is supplied by the *posterior tibial nerve*. It is a plantar-flexor and an invertor of the foot.

Flexor Retinaculum (Lig. laciniatum).—The connexions of this thickened band of the deep fascia should now be carefully re-examined. It bridges across the hollow between the medial malleolus and the medial tubercle of the calcaneum, and is attached to both of them. It has already been shown that its proximal border is continuous not only with the investing deep fascia of the back of the leg but also with the septum which covers the deep muscles (see p. 341); and it has been pointed out that the septum takes a more important part in the formation of the retinaculum than the investing layer of deep fascia does. Its distal or anterior margin is continuous with the deep fascia of the medial part of the sole, and also gives attachment to the muscle which is under cover of that portion of fascia—the abductor hallucis. The retinaculum is pierced by the medial calcanean nerves and vessels, and by a vein which connects the long saphenous vein with the posterior tibial veins.

The structures under cover of the retinaculum lie in the following order from the medial to the lateral side:

(1) The tendon of the tibialis posterior.
(2) The tendon of the flexor digitorum longus.
(3) The end of the posterior tibial artery and the commencement of the medial and lateral plantar arteries, with their accompanying veins.
(4) The posterior tibial and the medial and lateral plantar nerves.
(5) The tendon of the flexor hallucis longus.

The tendons are isolated from one another, and from the vessels and nerve, by septa which pass from the deep surface of the retinaculum to ridges on the adjacent bones. To demonstrate the septa, slit open the retinaculum for a short distance along the line of each tendon. Each of those three compartments will then be seen to be lined with a glistening synovial sheath; and the dissector should investigate the extent of each sheath as far as possible, with the aid of a blunt probe. The sheaths end proximally about one inch above the medial malleolus. Distally, the sheath of the tibialis posterior reaches the insertion of the tendon into

the navicular bone. The sheath of the flexor digitorum longus extends to about the middle of the length of the foot ; and that of the flexor hallucis longus can be traced, under favourable circumstances, as far as the middle of the first metatarsal bone (Fig. 157).

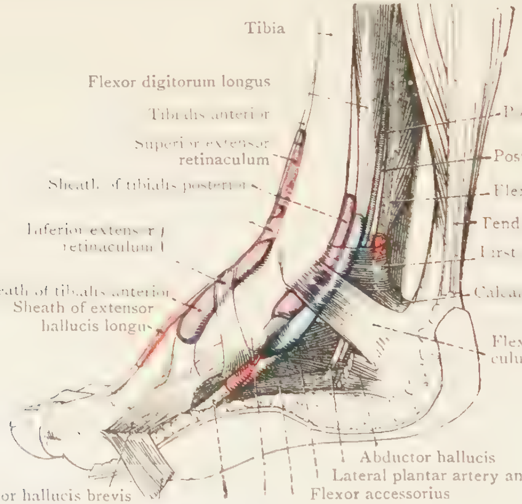


FIG. 157.—Dissection of Leg and Foot showing Synovial Sheaths.

Anastomosis around the Ankle Joint. The dissector should next satisfy himself with regard to the anastomosis of arteries which takes place around the ankle joint. On the *lateral side* of the joint, he will observe inosculations taking place between branches of the following arteries :—(*a*) lateral malleolar ; (*b*) perforating branch of peroneal ; (*c*) terminal part of peroneal ; and (*d*) lateral tarsal.

On the *medial side* of the joint, the medial malleolar branch of the anterior tibial anastomoses with small twigs from the medial calcanean branches of the posterior tibial.

Sole of the Foot

In this dissection the following structures are met with :—

1. Superficial fascia and cutaneous vessels and nerves.
2. Deep fascia, including the plantar aponeurosis.
3. Superficial muscles, { Abductor hallucis. Flexor digitorum brevis. Abductor digiti minimi.

4. Lateral and medial plantar vessels and nerves.
5. Tendons of flexor hallucis longus and flexor digitorum longus.
6. Flexor accessorius and lumbrical muscles.
7. Flexor hallucis brevis.
8. Adductor hallucis—transverse and oblique heads.
9. Flexor digiti minimi brevis.
10. Plantar arterial arch.
11. Plantar metatarsal and digital arteries.
12. Tendons of peroneus longus and tibialis posterior.
13. Interosseous muscles.

Before commencing the dissection, revise the surface anatomy (p. 310), and note that the skin is specially thick over the heel, on the ball of the foot, and, to a less extent, along the lateral border of the foot; on all those parts the weight of the body presses in the erect posture. Other noticeable features are the shortness of the toes as contrasted with the length of the fingers, and the fact that the longest digit of the foot is either the first or the second, and not, as in the case of the hand, the middle digit.

Dissection.—Reflexion of Skin.—The limb should be placed upon the table, with the sole of the foot facing the dissector, and the ankle supported by a good-sized block. Two incisions are required—(1) a longitudinal incision along the middle line of the sole, from the heel to the root of the middle toe; (2) a transverse cut, across the sole at the roots of the toes. Reflect the skin to the lateral and medial sides. Make also a longitudinal incision along each toe, and reflect the skin from the toes.

Superficial Fascia.—When the skin is reflected, the peculiar character of the superficial fascia becomes apparent. Along the lateral border of the foot, at the ball of the foot, and at the heel, it is thick, tough and granular. Traversing it, there are tough, fibrous bands which subdivide the fatty tissue into small lobules, and connect the skin with the deep fascia.

Under the heel, the superficial fascia contains branches of the *medial calcanean vessels* and *nerves*. Farther forwards, the small vessels and nerves that ramify in it are unnamed. On the sides of the toes, it contains the *plantar digital vessels* and *nerves*. Near the webs of the toes, a weak band of fibres, called the *superficial transverse ligament of the sole*, lies superficial to the digital vessels and nerves.

Dissection.—Trace the *medial calcanean arteries* and *nerves* to their distribution.

The superficial fascia may now be removed. Divide it along the middle line of the sole, and turn it laterally and medially, cleaning the deep fascia at the same time. As you approach the margins of the foot, note two longitudinal furrows, and

secure the small vessels and nerves that pass from the plantar vessels and nerves through the furrows to reach the skin.

Proceed cautiously as you approach the intervals between the heads of the metatarsal bones, for, there, the *metatarsal arteries* and *digital nerves* are unprotected by the deep fascia. The nerves and vessels which go to the medial side of the big toe and to the fibular side of the little toe are especially liable to injury, as they perforate the deep fascia farther back than the others. Look for the *superficial transverse ligament of the sole* at the roots of the toes.

Trace the digital nerves and arteries forwards along the sides of the toes. Then, clean the superficial fascia from the big toe and, at least, one of the others.

Deep Fascia.—The deep fascia of the plantar surface of the foot and toes is now brought into view. Study the deep fascia of the toes first.

On each toe, the deep fascia is thickened to form a curved plate, called the **fibrous flexor sheath**, that holds the flexor tendons against the phalanges. It is strong and dense opposite the phalanges, but is thin and weak opposite the joints in order that it may not hamper their movements. Its margins are attached to the margins of the first and second phalanges (only the first in the big toe), and to the margins of the plantar ligaments of the joints. Anteriorly, it is fixed to the base of the terminal phalanx just beyond the insertion of the long flexor tendon. Posteriorly, its curved end is continuous with the slips of the plantar aponeurosis described on p. 356.

The fibrous flexor sheath, being attached to the margins of the phalanges and plantar ligaments, forms, with them, a tunnel which is occupied by the long and short flexor tendons ; and the tunnel is lined with the synovial sheath that envelops the tendons. Slit open one of the fibrous sheaths to see the tendons and the synovial sheath ; and then proceed to study the deep fascia of the sole.

The deep fascia of the sole is divisible into three portions — (*a*) a medial, (*b*) an intermediate, and (*c*) a lateral. The subdivision is indicated by a difference in the density of the three parts and by two shallow furrows which traverse the foot in a longitudinal direction. Each of the three portions is in relation to a muscle which takes partial origin from it.

The *medial portion* is the thin fascia that covers the abductor hallucis. The *lateral portion* covers the abductor digiti minimi. It is stronger than the medial portion, especially laterally, where it is thickened to form a strong band that

stretches from the lateral tubercle of the calcaneum to the base of the fifth metatarsal bone (Figs. 158, 159).

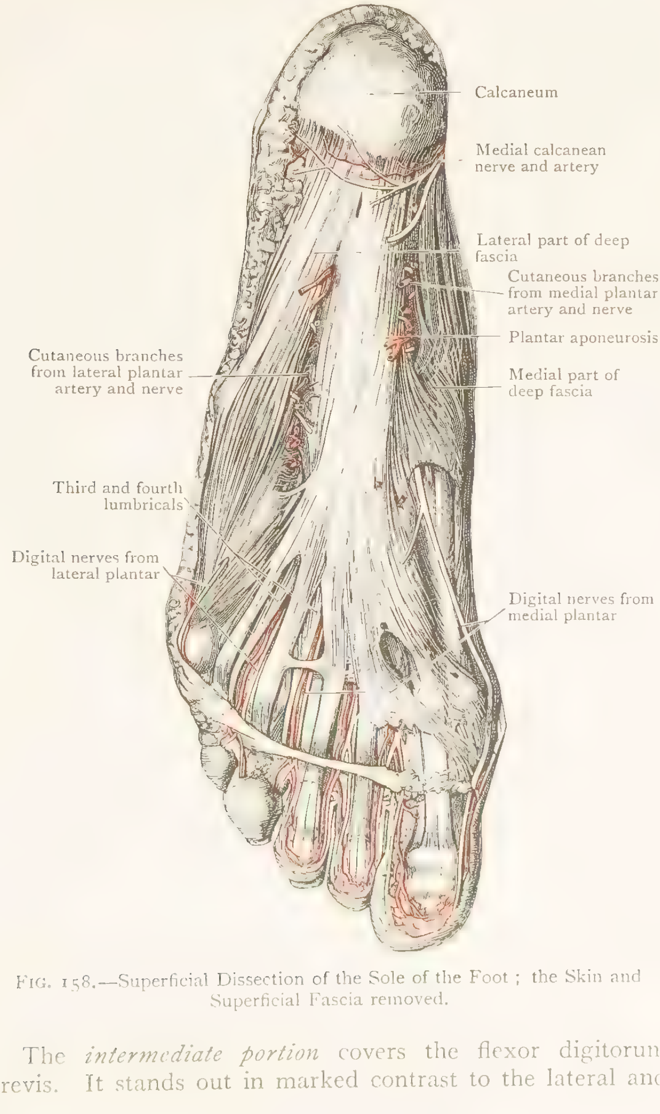


FIG. 158.—Superficial Dissection of the Sole of the Foot; the Skin and Superficial Fascia removed.

The *intermediate portion* covers the flexor digitorum brevis. It stands out in marked contrast to the lateral and

medial portions in point of strength and density, and is called the **plantar aponeurosis.** Its posterior end is narrow, and is attached to the medial tubercle of the calcaneum. It expands as it passes forwards, and, near the heads of the metatarsal bones, it splits into five processes, which are bound together by transverse fibres, and proceed towards the toes. In the interval between each two of those digital processes, a small artery and nerve and a delicate muscle are seen ; they are a plantar metatarsal artery, a plantar digital nerve and a lumbrical muscle.

Trace the processes forwards. One goes to the root of each toe ; there, it sends forwards a few superficial fibres to the skin of the creases of the toes, and then divides into two slips. The two slips diverge from each other and embrace the flexor tendons of the toe ; their distal edges fuse with the proximal end of the fibrous flexor sheath ; their ends pass upwards to be attached to the margins of the plantar ligament of the metatarso-phalangeal joint and to the deep transverse ligaments of the sole which are flat, fibrous bands that will be dissected later.

In connexion with the plantar aponeurosis two *intermuscular septa* also have to be studied (Fig. 158). These pass upwards into the sole, along the lines of the longitudinal furrows. They consequently lie one upon each side of the flexor digitorum brevis, and form partitions which separate it from the abductor hallucis and the abductor digiti minimi. They give partial origin to those muscles, and fuse with the layer of fascia that covers their deep surfaces.

Dissection. To demonstrate these septa, make a transverse incision through the plantar aponeurosis, about an inch in front of the medial tubercle of the calcaneum, and also a longitudinal cut through the aponeurosis, extending from the first incision along the middle line of the foot. Now, raise the divided aponeurosis and throw it laterally and medially. As the margins of the flexor digitorum brevis are approached, the septa are brought into view. As the anterior part of the aponeurosis is reflected, avoid injury to the plantar digital arteries and nerves, which lie close to its deep surface.

Muscles and Tendons of the Sole.—It is customary to look upon the muscles and tendons of the sole as being disposed in four strata, in or between which lie the plantar vessels and nerves and their branches, whilst the layers themselves are separated from one another by fascial partitions :—

First layer.	Abductor hallucis. Flexor digitorum brevis. Abductor digiti minimi.
Second layer.	Tendon of flexor digitorum longus. Flexor digitorum accessorius (quadratus plantæ). Lumbrical muscles. Tendon of flexor hallucis longus.
Third layer.	Flexor hallucis brevis. Adductor hallucis, oblique and transverse heads. Flexor digiti minimi brevis.
Fourth layer.	Tendon of peroneus longus. Tendon of tibialis posterior. Interosseous muscles.

Dissection.—Separate the lateral and medial portions of the deep fascia from the subjacent muscles, taking great care to avoid injury to the digital nerve to the lateral side of the little toe, and the digital nerve and artery to the medial side of the big toe. To avoid injuring those structures, sieze a reflected portion of the plantar aponeurosis, and cut horizontally through the septum at the side of the flexor digitorum brevis ; then keep the edge of the scalpel playing closely against the deep surface of the fascia that is being removed.

Before proceeding further with the dissection, identify the structures exposed by the removal of the deep fascia.

The *abductor hallucis* lies along the medial border of the sole ; a little lateral to it, there is a portion of the tendon of the *flexor hallucis longus* ; the *digital artery* and *nerve* to the medial side of the big toe lie between them ; and the muscle seen on a deeper plane is the *flexor hallucis brevis*, which, however, belongs to the third layer of muscles.

The *abductor digiti minimi* lies along the lateral border of the sole. Medial to its anterior half, the *digital nerves* and *vessels* to the little toe are seen, and, on a deeper plane, the *flexor digiti minimi* (which also belongs to the third layer) ; while, more medially still, a portion of an *interosseous muscle* is visible, though it belongs to the fourth layer.

In the intermediate area, there is the *flexor digitorum brevis*, dividing into four tendons for the lateral four toes. *Digital nerves* and *vessels* and *lumbrical muscles* are seen between those four tendons and between the most medial tendon and the flexor hallucis longus.

Dissection.—Cut down into the posterior part of the interval between the abductor hallucis and the flexor digitorum brevis, immediately in front of the medial tubercle of the calcaneum, and secure the posterior parts of the *medial* and *lateral plantar nerves* and *arteries*. Follow the *medial plantar nerve* forwards, and secure the two muscular branches that arise from its trunk. Then, trace its *four digital branches* forwards to the toes, securing

—(1) a muscular branch from the most medial one, (2) a muscular branch from the second, and (3) a communicating branch from the fourth to a digital branch of the lateral plantar nerve. At the same time, clean the *medial plantar artery* and its branches.

Next, cut down into the interval between the flexor digitorum brevis and the abductor digiti minimi, just behind the base of the fifth metatarsal bone, and secure the *lateral plantar artery* and the trunk of the *lateral plantar nerve*, before the nerve divides into its superficial and deep divisions. The artery and the deep division of the nerve bend medially, and pass out of sight. Follow the superficial division of the nerve forwards, and secure—(1) the branches to the flexor digiti minimi brevis, and the interossei of the fourth interosseous space; (2) its two digital branches to the fourth and fifth toes. Clean also the arteries which accompany the nerves.

Now, divide the flexor digitorum brevis across its middle; throw the anterior part forwards to the toes; turn the posterior part backwards, and define its attachments; at the same time, clean the part of the abductor digiti minimi that passes deep to it. Next, detach the abductor hallucis from the calcaneum (but not from the flexor retinaculum) and turn it medially.

The additional structures exposed (Figs. 159, 160) are:—

1. The greater part of the *lateral plantar vessels* and *nerve* and their branches.
2. Deep to the vessels and nerve, a short, wide sheet of muscle, called the *flexor accessorius* (quadratus plantæ), divided posteriorly into two heads.
3. The posterior part of a strong fibrous band, called the *long plantar ligament*, between the two heads of the flexor accessorius.
4. The tendon of the *flexor digitorum longus*, medial and distal to the flexor accessorius and giving insertion to it, and dividing into four tendons for the lateral four toes.
5. The four *lumbrical muscles*, arising from those tendons.
6. A further portion of the *flexor hallucis longus*, seen at the medial side of the flexor digitorum, as it escapes from under cover of the digitorum.
7. The *flexor hallucis brevis*—more evident than it was—with the tendon of the long flexor lying in the groove between its two bellies.

Dissection. Clean the *lateral plantar nerve* and its muscular branches. The first branch goes to the abductor digiti minimi; it lies far back, close to the tubercles of the calcaneum. The branch to the flexor accessorius is a little farther forward. Next, clean the *lateral plantar artery* and its branches. Finally, clean the muscles and tendons.

First Layer of Muscles.—The **flexor digitorum brevis** arises from the medial tubercle of the calcaneum, and from the fascia and the septa. About the middle of the sole, it divides into four fleshy slips which end in slender tendons for the lateral four toes. Each tendon enters the fibrous flexor sheath of its toe, and is inserted into the middle phalanx; it will be studied later.

The flexor digitorum brevis is supplied by the *medial plantar nerve*. It is a flexor of the first interphalangeal joints and the metatarso-phalangeal joints of the lateral four toes.

The **abductor hallucis** takes origin chiefly from the flexor retinaculum, and partly from the medial tubercle of the calcaneum. A strong tendon issues from the fleshy belly. This is joined, on its lateral and deep surface, by fibres of the medial belly of the flexor hallucis brevis ; and it is inserted into the medial side of the base of the proximal phalanx of the big toe.

The abductor hallucis is supplied by the *medial plantar nerve*. It abducts the big toe from the second toe.

The **abductor digiti minimi** arises from both tubercles of the calcaneum ; and the medial part of it, near its origin, is therefore under cover of the flexor digitorum brevis. Its tendon is inserted into the lateral side of the base of the proximal phalanx of the little toe. The lateral portion of the muscle is often inserted into the base of the fifth metatarsal bone ; that portion is called the *abductor of the fifth metatarsal bone*.

The abductor digiti minimi is supplied by the *lateral plantar nerve*. It abducts the little toe from the fourth toe.

Dissection.—Separate the abductor hallucis from the flexor retinaculum, and turn it medially ; then, divide the retinaculum until the origins of the plantar arteries and nerves are exposed.

Plantar Nerves and Vessels.—The medial plantar nerve is the larger of the two terminal branches of the posterior tibial nerve. It arises, under cover of the flexor retinaculum about midway between the calcaneum and the medial malleolus. From the retinaculum, it passes under cover of the abductor hallucis, and then appears in the interval between that muscle and the flexor digitorum brevis, where it is under cover of the deep fascia. It lies first on the flexor accessorius (quadratus plantæ), and then on the tendons of the long flexors of the toes ; and the medial plantar vessels lie along its medial side (Figs. 159, 163). It gives off *muscular* and *cutaneous* branches, a digital branch to the medial side of the big toe, and then ends, at a variable point, by dividing into three other *digital* branches.

The *cutaneous twigs* spring from the trunk of the nerve, and pierce the deep fascia in the line of the medial intermuscular septum and supply the skin of the medial part of the sole.

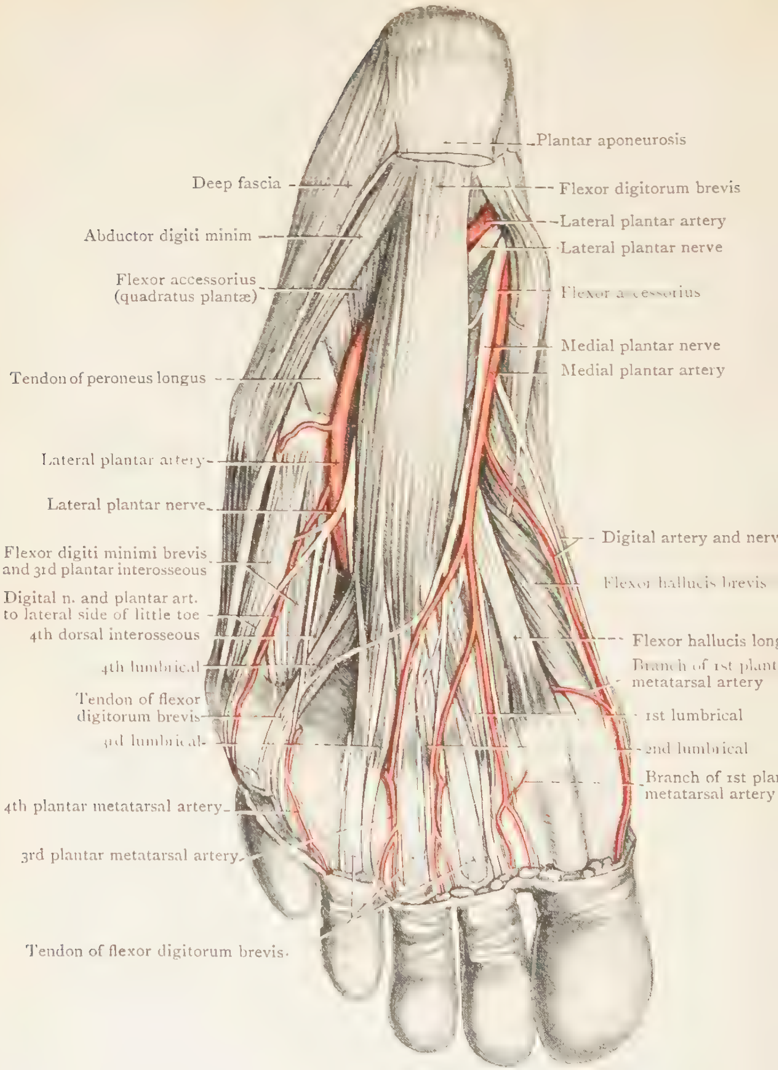


FIG. 159.—Superficial dissection of the Sole of the Foot. The plantar aponeurosis has been removed. The abductor digiti minimi and the abductor hallucis have been pulled aside.

The *digital branches* supply the skin of the plantar surfaces of three and a half toes—the first, second, third, and half the fourth. They also supply the skin over the dorsal surfaces of the terminal phalanges, and the joints and ligaments of those toes.

The *first digital nerve* arises as the medial plantar nerve escapes from under cover of the abductor hallucis; it runs forwards over the flexor hallucis brevis, and then along the medial side of the big toe.

The *three terminal digital branches* arise in front of the middle of the foot. They diverge from one another, and run forwards, superficial to the flexor tendons and the lumbricals, towards the clefts between the medial four toes. Near the clefts, they pierce the deep fascia, and each divides into two branches which run along the adjacent sides of two toes. The most lateral digital nerve sends a communicating branch to the superficial part of the lateral plantar nerve.

The digital distribution of the medial plantar nerve closely resembles that of the median nerve in the hand.

The *muscular branches* go to four muscles of the sole:—

Abductor hallucis.	Flexor hallucis brevis.
Flexor digitorum brevis.	First lumbrical.

The branches which supply the *abductor hallucis* and the *flexor digitorum brevis* arise from the trunk of the medial plantar nerve a short distance from its origin. The nerve to the *flexor hallucis brevis* arises from the first digital nerve; and the nerve to the *first lumbrical muscle* springs from the second digital nerve.

The **lateral plantar nerve** corresponds to the ulnar nerve in the palm of the hand. It is the smaller terminal branch of the posterior tibial nerve. It begins, under cover of the flexor retinaculum, about midway between the medial malleolus and the calcaneum. It runs laterally and forwards, between the first and second layers of muscles, towards the base of the fifth metatarsal bone, and ends near that base by dividing into a superficial branch and a deep branch. The lateral plantar vessels lie along its lateral side; the two plantar nerves are, therefore, between the two plantar arteries. The lateral plantar nerve lies first on the tendon of the flexor hallucis longus and then on the flexor accessorius, and, finally, on the tendon of the peroneus longus (Fig. 160). It is under cover of the following structures in succession—flexor retina-

culum, abductor hallucis, flexor digitorum brevis. At its termination, it may still be deep to the flexor brevis, or may lie

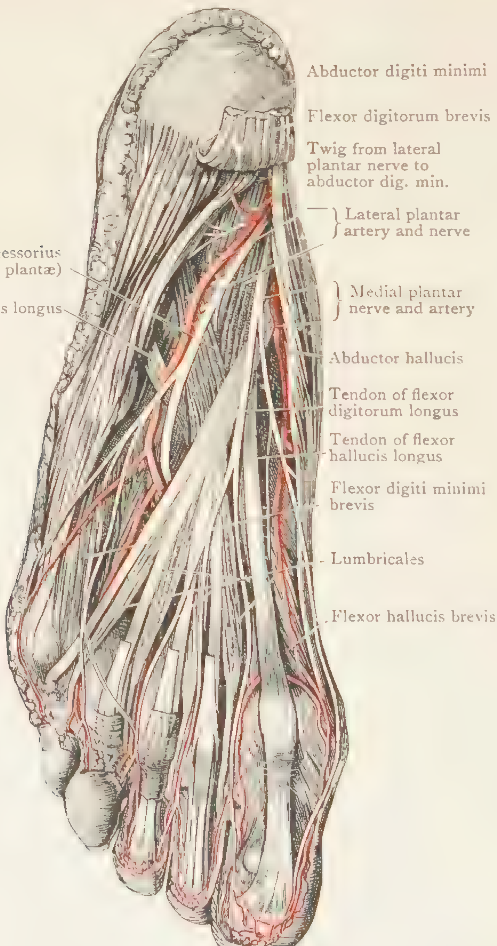


FIG. 160.—Dissection of the Sole of the Foot. The flexor digitorum brevis has been reflected.

under cover of the deep fascia in the interval between that muscle and the abductor digiti minimi.

The branches that spring from the trunk of the lateral plantar nerve are muscular and cutaneous.

The *muscular* branches supply the *abductor digiti minimi* and the *flexor accessorius* (quadratus plantæ). The *cutaneous* branches appear through the interval between the flexor digitorum brevis and the abductor digiti minimi, and supply the skin of the lateral part of the sole.

The *superficial branch* of the lateral plantar nerve divides at a varying point (Figs. 159, 160) into two digital branches.

The *lateral digital branch* runs forwards over the flexor digiti minimi brevis, pierces the deep fascia, and runs along the lateral side of the little toe. The *medial digital branch* runs forwards over the third plantar interosseous muscle, the flexor tendons of the little toe and the fourth lumbrical muscle, pierces the deep fascia, and divides into two branches which run along the contiguous sides of the fifth and fourth toes. It receives a communicating branch from the fourth digital branch of the medial plantar nerve.

Muscular twigs arise either from the stem of the superficial branch or from the lateral digital branch. They supply the flexor digiti minimi brevis and the third plantar and fourth dorsal interosseous muscles.

The *deep branch* is really the continuation of the lateral plantar nerve. It curves medially and forwards, between the third and fourth layers of muscles, towards the first metatarsal bone, and will be dissected later. Its branches are *muscular* and *articular*; they supply the adductor of the big toe, the lateral three lumbricals, and most of the interossei; and they send filaments to the inter-tarsal and tarso-metatarsal joints.

The **medial plantar artery** arises, as a terminal branch of the posterior tibial, under cover of the flexor retinaculum. It varies in size but usually is small. It is accompanied by venæ comitantes, and runs along the medial side of the medial plantar nerve; and it ends by joining the digital branch which the first metatarsal artery sends to the medial side of the big toe (Fig. 163).

It gives *muscular* branches to adjacent muscles, *cutaneous* branches to the medial part of the foot; and, according to its size, it may give off one or more *digital* branches to accompany the digital branches of the medial plantar nerve (Fig. 159).

The **lateral plantar artery** is the larger of the two terminal

branches of the posterior tibial artery. It arises under cover of the flexor retinaculum, and, accompanied by venæ comitantes, it runs across the sole along the lateral side of the lateral plantar nerve, to the fifth metatarsal bone near its base. It then runs medially with the deep branch of the nerve—thus, crossing the sole for the second time. This second portion is called the **plantar arch**. It lies deep in the sole, in front of the nerve, and terminates at the proximal extremity of the first intermetatarsal space by joining the end of the dorsalis pedis artery. The arch will be dissected later.

The branches of the part of the artery now exposed are —(1) *Muscular* branches to adjacent muscles. (2) *Cutaneous* branches to the lateral and posterior parts of the sole.

Dissection.—Detach the abductor digiti minimi from its origin, and turn it forwards, in order that a good display may be obtained of the second stratum of the sole.

Second Layer of Muscles and Tendons.—As the tendon of the *flexor hallucis longus* enters the sole it grooves the plantar surface of the sustentaculum tali and inclines medially, deep to the tendon of the flexor digitorum longus, towards the big toe. The tendon of the *flexor digitorum longus*, on the other hand, inclines laterally, superficial to the tendon of the flexor hallucis longus, to reach the middle of the foot, where it divides into four tendons for the lateral four toes; it receives the insertion of the *flexor accessorius*, and its four tendons give origin to the *lumbrical muscles*. Where the long tendons cross each other, the tendon of the flexor hallucis longus gives a slip to the deep surface of the tendon of the flexor digitorum longus.

Sir William Turner called attention to the fact that this slip varies greatly in thickness and distribution. Its fibres may all go into the tendon for the second toe; they usually go into the tendons for the second and third toes, or second, third and fourth; very rarely do they go into all four tendons.

Dissection. Turn over the tendons of the flexor digitorum and trace the fibres of the slip of the flexor hallucis into them. Then, follow the tendons of the long and short flexors to the toes, and open one of the fibrous flexor sheaths (if that has not been done already).

The **flexor digitorum accessorius** (quadratus plantæ) takes a course straight forwards from the heel, and acts as a direct flexor of the toes. It also tends to bring the tendons of the long flexor muscle into a line with the toes upon which they

operate. It arises by two heads which embrace the calcaneum and the long plantar ligament. The *medial head*, wide and fleshy, springs from the medial surface of the calcaneum; the *lateral head*, narrow, pointed and tendinous, takes origin from the lateral margin of the plantar surface of the calcaneum. The muscle is inserted into the tendon of the flexor digitorum longus in the middle of the sole. It is supplied by the *lateral plantar nerve*.

The **lumbrical muscles** of the foot are more slender than the corresponding muscles of the hand. They are four in number, and arise from the tendons of the flexor digitorum longus. The lateral three lumbricals spring from the adjacent sides of the tendons between which they lie; the first or most medial muscle takes origin from the medial side of the tendon which goes to the second toe. The tendons of the lumbrical muscles pass upwards and forwards across the medial sides of the metatarso-phalangeal joints of the lateral four toes, and each is inserted into the base of the proximal phalanx and slightly into the extensor expansion (see p. 319). The *first* or *most medial lumbrical* is supplied by the *medial plantar nerve*; the *others* are supplied by the *lateral plantar nerve*.

Insertions of Flexor Tendons.—In each digit, an osteo-fibrous canal is formed by the fibrous flexor sheath and the phalanges and plantar ligaments of the joints.

The **tendon of the flexor hallucis longus**, after giving its slip to the tendon of the flexor digitorum longus, runs forwards to the big toe, and is inserted into the base of the terminal phalanx. It is retained in place by a fibrous flexor sheath, and is enclosed in a synovial sheath.

Two tendons enter the canal in each of the four smaller toes—a tendon of the **flexor digitorum brevis** and a tendon of the **flexor digitorum longus**. Opposite the posterior part of the first phalanx, the short flexor is superficial; but, at the middle of the phalanx, the tendon of the short flexor is perforated by the tendon of the long flexor, which passes forwards to be inserted into the base of the terminal phalanx, whilst the tendon of the short flexor, beyond the perforation, splits into two parts which are attached to the margins of the second phalanx.

Synovial Sheaths of the Digits.—The osteo-fibrous canal is lined with a synovial sheath, which begins in the sole near the middle of the metatarsal bone, and extends to the

insertion of the long flexor tendon, *i.e.* to the *base* of the terminal phalanx.

The sheath has two layers. One layer lines the canal. The other layer clothes the tendons, enveloping them separately. The two layers are continuous with each other at the ends of the sheath. The sheath facilitates the play of the tendons when the muscles are in action, for the opposed surfaces of the layers are smooth and glistening, and are coated with a film of synovia.

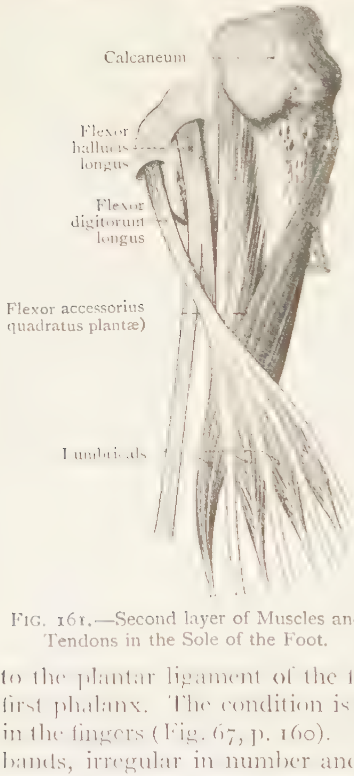


FIG. 161.—Second layer of Muscles and Tendons in the Sole of the Foot.

The sheath forms folds called *vincula* which aid in attaching the tendons to the bones, and in which small arteries run from the bone to the tendons.

There are two sets of vincula—short and long. Two *short vincula* are present in each sheath. They are short triangular folds containing some yellow elastic tissue. One of them connects the tendon of the long flexor to the plantar ligament of the terminal interphalangeal joint and the adjacent part of the second phalanx, and the other connects the tendon of the short flexor in a similar manner to the plantar ligament of the first interphalangeal joint and first phalanx. The condition is exactly similar to that found in the fingers (Fig. 67, p. 160). The *vincula longa* are slender bands, irregular in number and position that pass between the two tendons, and between the tendons and the first phalanx.

Dissection.—To bring the third layer of muscles into view: Divide the two heads of the flexor accessorius, and draw the muscle forwards from the lateral plantar vessels and nerve. Sever also the tendons of the flexor digitorum longus

and the flexor hallucis longus at the point where they emerge from under cover of the flexor retinaculum, and turn them towards the toes, after cutting the branch from the lateral plantar nerve to the flexor accessorius. As the tendons of the long flexor of the toes are turned forwards, the lumbrical muscles will be raised, and the nerves to the *second*, *third*, and *fourth* must be looked for. Lastly, cut the medial plantar nerve close to its origin and turn it aside.

Third Layer of Muscles.—The *flexor hallucis brevis* lies on the first metatarsal bone, along the lateral side of the abductor hallucis.

The *oblique head of the adductor hallucis* has a very oblique position in the sole, and hides the interosseous muscles to a great extent. It lies lateral to the flexor hallucis brevis.

The *transverse head of the adductor hallucis* lies across the plantar ligaments of the metatarso-phalangeal joints.

The *flexor digiti minimi brevis* lies on the fifth metatarsal bone.

The deep division of the lateral plantar nerve and the plantar arterial arch are partially exposed, but they will be more fully displayed at a later stage.

Dissection.—Clean all those muscles from end to end, but avoid injury to the branches of the deep division of the lateral plantar nerve—especially its branches to the lumbrical muscles. Clean also the exposed part of the plantar arch.

The **flexor hallucis brevis** arises from the cuboid bone and from adjoining slips of the tendon of the tibialis posterior. It is narrow and tendinous at its origin, but it soon widens to form two partially separated fleshy bellies which ultimately divide to be inserted one on each side of the base of the proximal phalanx of the big toe. In the tendons of insertion two sesamoid bones are developed (Fig. 165); they play upon the plantar surface of the head of the first metatarsal bone, which is grooved to articulate with them; and the medial part of the ball of the foot owes its size and firmness largely to them. The medial tendon is inserted in common with the abductor hallucis, and the lateral tendon with the adductor.

The flexor hallucis brevis is supplied by the *medial plantar nerve*. It flexes the first metatarso-phalangeal joint.

The **adductor hallucis** has two separate heads—oblique and transverse (Fig. 162).

The *oblique head* arises from the fibrous sheath of the peroneus longus tendon and from the bases of the second, third, and fourth metatarsal bones. It extends forwards and

medially, tapering as it approaches the root of the hallux, and is inserted, with the lateral tendon of the flexor hallucis

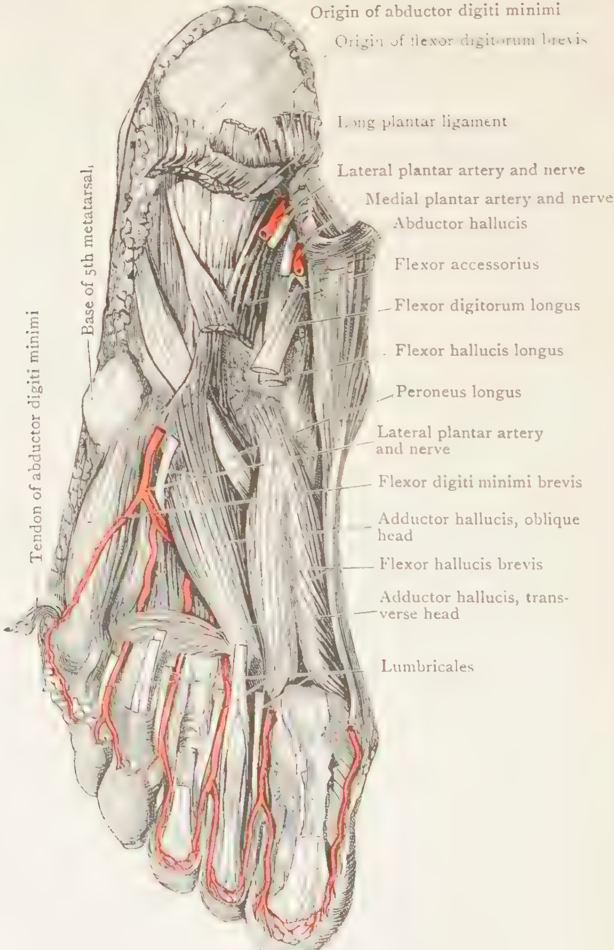


FIG. 162.—Deep Dissection of the Sole of the Foot.

brevis, into the lateral side of the base of the proximal phalanx. The *transverse head* springs by a series of slips from the plantar ligaments of the lateral four metatarso-phalangeal

joints at their metatarsal attachments, and proceeds medially, under cover of the flexor tendons, to find insertion in common with the oblique head.

Both heads of the adductor hallucis are supplied by the *deep division* of the *lateral plantar nerve*. The oblique head adducts and flexes the big toe ; the transverse head draws the roots of the toes closer together and accentuates the curvature of the low, transverse arch made by the metatarsal bones.

The **flexor digiti minimi brevis** is a single fleshy slip which springs from the base of the fifth metatarsal bone and the fibrous sheath of the peroneus longus tendon. It is inserted into the lateral side of the base of the proximal phalanx of the little toe. Its nerve of supply arises from the *superficial division* of the *lateral plantar nerve*. It is a flexor of the metatarso-phalangeal joint of the little toe.

Dissection.—Detach the flexor hallucis brevis and the oblique head of the adductor from their origins and throw them towards their insertions, in order to display the entire length of the plantar arterial arch, the deep division of the lateral plantar nerve, and the termination of the dorsalis pedis artery. As you raise the oblique head of the adductor, secure its nerve and retain it. Then, clean the *deep division of the plantar nerve*, and trace its branches ; the branch to the second lumbrical needs especial care. Lastly, clean the *plantar arch* and its branches.

Deep Division of the Lateral Plantar Nerve. The deep branch of the lateral plantar nerve arises from the parent trunk near the base of the fifth metatarsal bone. It curves medially and forwards towards the medial side of the foot, and ends in the deep or upper surface of the oblique head of the adductor hallucis.

It is deeply placed in the sole, immediately behind the plantar arterial arch. It rests against the interosseous muscles and the posterior parts of the metatarsal bones, under cover of the flexor tendons, the lumbrical muscles and the oblique head of the adductor hallucis.

The branches of the deep division of the lateral plantar nerve are *muscular* and *articular*.

The *muscular branches* supply the two heads of the *adductor hallucis*, the lateral three *lumbrical* muscles, the medial three dorsal *interossei* and the medial two plantar interossei.

The branches to the transverse head and to the lumbricals

emerge from under cover of the oblique head and run forwards and downwards to these muscles; but the branch to the second lumbrical passes across the upper surface of the transverse head before it turns downwards to its muscle.

The *articular branches* are fine filaments that arise from

FIG. 163.—Arteries and Nerves of the Sole of the Foot. (Diagram.)
The plantar nerves and their branches are uncoloured.

the stem and from the muscular branches; they supply the intertarsal and tarso-metatarsal joints.

Plantar Arch. The plantar arterial arch is the continuation of the lateral plantar artery across the sole of the foot. It runs from the level of the base of the fifth metatarsal bone to the base of the first interosseous space, where it is joined by the terminal portion of the dorsalis pedis artery. Its course is curved, with the concavity backwards (Figs. 163, 164). It

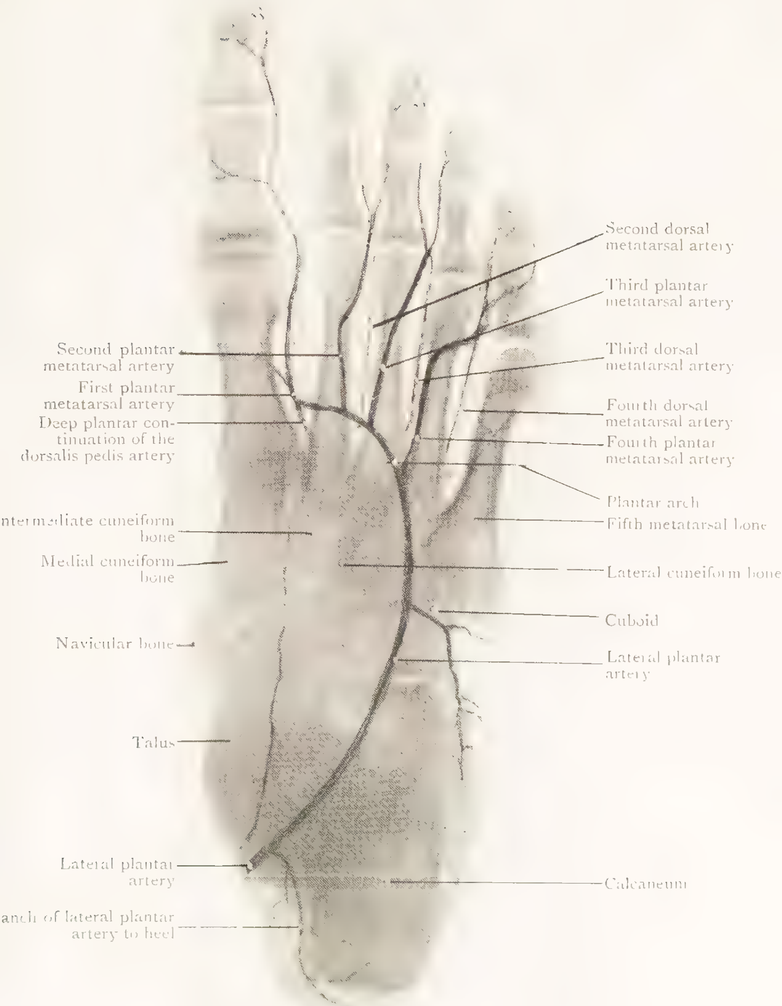


FIG. 164. - Radiograph of an Injected Foot showing the relations of some of the arteries to the bones.

FIG. 165. Radiograph of Foot of man aged 48. The foot was plantar-flexed, with the sole against the film container

is accompanied by two venæ comitantes, and lies immediately in front of the deep branch of the lateral plantar nerve; its relations are therefore the same as those of the nerve.

The branches which proceed from the arch are :—

1. Articular.
2. Posterior perforating.
3. Second, third, and fourth plantar metatarsal arteries.
4. Plantar digital artery to the lateral side of the little toe.

The *articular branches* arise from the concavity of the arch, and run backwards to supply the intertarsal and tarso-metatarsal joints.

The *posterior perforating branches* are three in number. They pass upwards through the lateral three intermetatarsal spaces and join the corresponding dorsal metatarsal arteries.

The *second*, *third*, and *fourth plantar metatarsal arteries* run forwards opposite the second, third, and fourth intermetatarsal spaces, pass above the transverse head of the adductor hallucis, and bifurcate into *plantar digital arteries* that supply the contiguous sides of the lateral four toes.

Immediately before it divides, each plantar metatarsal artery sends upwards an *anterior perforating artery* which joins the corresponding dorsal metatarsal artery.

The *plantar digital artery to the lateral border of the little toe* springs from the lateral extremity of the plantar arch, crosses the plantar surface of the flexor digiti minimi brevis, and runs forwards to the distal end of the toe.

On the sides of the toes, the plantar digital arteries lie above the nerves. They supply the bones and the soft parts on the sides and plantar surfaces of the toes; opposite the terminal phalanx, the two arteries of each toe unite to form an arch from which fine branches are sent to the pad of the toe and the bed of the nail.

First Plantar Metatarsal Artery—This artery arises from the plantar end of the dorsalis pedis, at the point where the dorsalis pedis joins the plantar arch. It runs forwards to the cleft between the big toe and the second toe, where it divides into two *plantar digital arteries* for the supply of the adjacent sides of the first and second toes. Before it divides, it gives off the plantar digital artery to the medial side of the big toe, which is joined by the terminal part of the medial plantar artery.

Dissection.—Detach the transverse head of the adductor hallucis from its origin and throw it medially, towards the hallux, to display the deep transverse ligaments of the sole.

Deep Transverse Ligaments of the Sole.—This name is given to four strong, flat bands that lie between the heads of the metatarsal bones. They are attached to the margins of the plantar ligaments of the metatarso-phalangeal joints; those plantar ligaments are firmly attached to the bases of the proximal phalanges; and, therefore, the transverse ligaments prevent the roots of the toes from spreading apart. The lumbrical muscles and the plantar digital vessels and nerves pass forwards across the plantar surfaces of the trans-

verse ligaments; and the interosseous muscles cross their dorsal surfaces.

Fourth Layer of Muscles and Tendons.—Owing to the arched arrangement of the skeleton of the foot, the more medial *interosseous muscles* are very deeply placed, while the more lateral members are near the surface, and are soon encountered in the dissection of the sole. The *tendon of the peroneus longus* crosses the sole obliquely from the lateral to the medial side; the slips of the *tendon of the tibialis posterior* pass laterally and forwards from the medial side. These tendons, crossing the sole obliquely from opposite directions, brace up the foot, and are the chief agents in maintaining both the longitudinal and the transverse arches.

Dissection. Clean the *interosseous muscles*. To follow their tendons, divide the deep transverse ligaments, and pull the toes apart. Detach the flexor digiti minimi brevis from its origin and throw it towards its insertion, in order to expose the most lateral interossei more fully.

There are seven **interosseus muscles**—three plantar and four dorsal. They lie in the intervals between the metatarsal bones, and they adduct and abduct the lateral four toes to and from the middle line of the second toe.

Their tendons slope upwards and forwards across the sides of the metatarso-phalangeal joints, and are inserted mainly into the bases of the proximal phalanges and also into the extensor expansions (p. 310). They have actions therefore in addition to adduction and abduction. Since they cross the metatarso phalangeal joint from below upwards, they flex that joint; since they are inserted into the extensor expansion, they help to extend the interphalangeal joints.

The *plantar interosseous muscles* are so placed that they adduct the lateral three toes towards the middle line of the second toe. They arise from the plantar and medial surfaces of the lateral three metatarsal bones, and each is inserted on the medial side of the corresponding toe.

The *dorsal interosseous muscles* occupy the four inter-metatarsal spaces, and consequently they must be dissected on both plantar and dorsal aspects of the foot. They are arranged so as to abduct the second, third, and fourth toes from the middle line of the second toe. Each arises by two heads from the dorsal parts of the adjacent sides of the meta-tarsal bones which bound the cleft in which it lies. They are

inserted as follows: the *first*, on the medial side of the second toe; the *second*, on the lateral side of the same toe; the *third*, on the lateral side of the third toe; and the *fourth*, on the lateral side of the fourth toe.

Dissection.—Put tension upon the tendon of the *tibialis posterior*. Clean its principal insertion and the various slips which it sends forwards and laterally. Then, pull upon the tendon of the *peroneus longus*; cut through the fibrous bridge that holds it in place in the groove of the cuboid bone, and follow the tendon to its insertion.

FIG. 166.—Insertions of Tibialis Posterior and Peroneus Longus in the Right Foot. (Paterson.)

The tendon of the **tibialis posterior** is inserted not merely into the tuberosity of the navicular bone. Fibrous slips spread out from it to every bone of the tarsus, with the exception of the talus, and also to the bases of the second, third, and fourth metatarsal bones. The slips to the second and third cuneiform bones give partial origin to the flexor hallucis brevis.

As the tendon of the tibialis posterior enters the sole and approaches its chief insertion, it lies on the plantar surface of a strong, flat band called the *plantar calcaneo-navicular ligament* or "spring ligament". The tendon is separated from the ligament by the distal part of its synovial sheath, and the surface of the ligament is therefore smooth and glistening. The ligament stretches from the sustentaculum tali of the calcaneum to the navicular bone, and supports the head of the talus. The tendon also, through the ligament, supports the talus; and, at this point, it has developed within

it a sesamoid nodule of fibro-cartilage, which may become a sesamoid bone.

The tendon of the **peroneus longus** turns round the lateral margin of the foot, and runs medially, across the sole, in the groove on the plantar surface of the cuboid bone, to reach its insertion into the base of the first metatarsal bone and adjoining part of the medial cuneiform bone. As it traverses the sole, it is covered with a strong sheet of fibrous tissue derived mainly from the long plantar ligament. This sheet is called the *fibrous sheath* of the peroneus longus. It is attached to the margins of the groove on the cuboid and prevents displacement of the tendon. Together with the groove on the cuboid, it forms a tunnel which is lined with the *synovial sheath* that envelops the tendon.

Just before the tendon enters the tunnel, it is thickened and contains a nodule of fibro-cartilage or a sesamoid bone which plays upon a facet situated on the posterior margin of the lateral end of the groove on the cuboid.

Dissection.—Bring the dissection of the sole of the foot to an end by disarticulating the proximal end of the first metatarsal bone. A good view is thus obtained of the continuity between the dorsalis pedis artery and the plantar arch.

JOINTS OF LOWER LIMB

The **hip joint** was dissected before the limb was removed from the body.

The dissection of the knee joint, the ankle joint, the tibio-fibular joints, and the various joints of the foot, may now be proceeded with. It is possible that the ligaments may have become hard and dry. If that is the case, soak the joints in water over-night.

Knee Joint (Articulatio Genu)

Three bones—the distal end of the femur, the patella and the proximal end of the tibia—take part in the formation of the knee joint, which is the largest and most complicated joint in the body.

In all positions of the joint, the patella is in contact with the femur and the femur with the tibia. The bones do not

interlock with one another; but the areas of contact are large and the ligaments and surrounding muscles are strong; dislocation of the joint is therefore rare, in spite of the many strains to which it is subjected.

The femoral condyles are partly separated from the tibial condyles by two sharply curved pieces of fibro-cartilage called the *semilunar cartilages*; they lie on the marginal parts of the tibial condyles (Fig. 167), and, being wedge-shaped in section, they slightly deepen the surfaces for articulation with the femoral condyles. In the interior of the joint, there are also two very strong bands which pass from the top of the tibia to the two femoral condyles; they cross each other, and are called therefore the *cruciate ligaments* of the knee; and they take the chief part in holding the femur and tibia together.

The three bones of the joint are united also by an imperfect *capsular ligament*, which envelops the joint incompletely, and by supplementary bands which have been partly examined already—namely, the *lateral* and *medial ligaments* of the knee, the *oblique posterior ligament*, and the *ligamentum patellæ*, which serves as an anterior ligament.

Before the dissection of the knee joint itself is commenced, the nerves which supply it, and the arteries which anastomose around it and provide its blood supply should be displayed and studied. Most of them have been dissected already in part of their extent. The nerves should now be traced as far as the capsular ligament of the joint; and, at the same time the vessels around the joint should be cleaned.

The nerves are :—

From femoral nerve.	Filaments from the nerves to the three vasti.
From obturator nerve . .	Genicular branch.
From lateral popliteal nerve.	Superior lateral genicular; Inferior lateral genicular; Recurrent genicular.
From medial popliteal nerve.	Superior medial genicular; Inferior medial genicular; Middle genicular.

Dissection. Find the *nerves to the vasti*, and trace their articular filaments down through each muscle to the knee. Clean the *descending branch of the lateral circumflex artery* and the *descending genicular artery* and their branches as far as possible. Find the branch that the posterior division of the obturator nerve sends into the adductor magnus; trace it into

the muscle, and follow its longest filament : it emerges from the muscle and becomes the *genicular branch.*

Trace the *superior genicular nerves* and *vessels* to the capsule of the joint; and note the *middle genicular nerve* and *vessels*, as they pierce the posterior ligament of the knee. The proximal part of the *inferior lateral genicular nerve* has probably been destroyed. But find the inferior lateral artery and trace it to the lateral ligament of the joint, and the nerve may be found alongside the artery there. Divide the biceps a little above the joint, and pull it downwards to expose the lateral ligament more fully. Clean the ligament from end to end ; and trace the nerve and artery forwards between it and the capsular ligament.

Follow the *inferior medial genicular nerve* and *vessels* along the upper border of the popliteus to the medial ligament. Throw the tendons of the sartorius, gracilis and semitendinosus forwards and pick up the nerve and vessels at the anterior border of the ligament, and trace them onwards.

Now, find the commencement of the anterior tibial artery, and secure its *posterior recurrent branch.* It passes upwards in front of the popliteus. Therefore, cut the popliteus near its lateral end, turn it medially, secure its nerve (which enters its deep surface), and look for a slender filament which the nerve sends to the interosseous membrane ; then, follow the recurrent artery to its termination. Lastly, turn to the front of the limb. Find the *anterior recurrent branch* of the anterior tibial artery and the *recurrent genicular nerve* ; trace them upwards through the tibialis anterior to the knee.

Articular Nerves of the Knee Joint.—The knee joint is richly supplied with nerves. No less than ten distinct branches may be traced to it. The femoral nerve and the lateral and medial popliteal nerves contribute three twigs apiece to it ; and the obturator nerve furnishes a filament.

The *femoral nerve* supplies the joint through branches which proceed from the nerves to the vasti. These nerves descend through the vasti, and are distributed to its upper and anterior part. The articular branch from the nerve to the vastus medialis is of larger size than the other two, and it accompanies an articular branch of the descending genicular artery.

The *lateral popliteal* (common peroneal) *nerve* gives off—(1) the superior and inferior lateral genicular nerves, which are accompanied by corresponding arteries ; and (2) the recurrent genicular nerve, which is accompanied by the anterior recurrent tibial artery.

The superior lateral genicular nerve arises above the popliteal fossa, descends into the fossa to join the artery, passes under cover of the biceps above the lateral femoral condyle, pierces the lateral intermuscular septum, and pierces

the vastus intermedius to reach the upper lateral part of the knee joint.

The inferior lateral genicular nerve is small, and may be

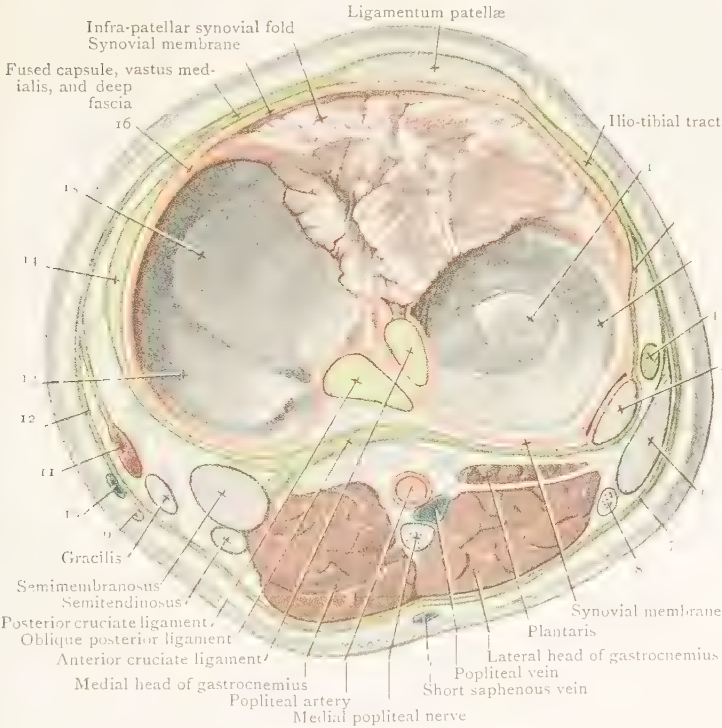


FIG. 167.—Transverse section through the Knee Joint and its surroundings, showing the relations of the Synovial Membrane.

1. Lateral condyle of tibia.
2. Capsular ligament.
3. Lateral semilunar cartilage.
4. Lateral ligament of knee.
5. Popliteus tendon.
6. Biceps femoris.
7. Deep fascia.
8. Lateral popliteal nerve.
9. Saphenous nerve.
10. Long saphenous vein.
11. Sartorius.
12. Deep fascia.
13. Medial semilunar cartilage (meniscus).
14. Medial ligament of knee.
15. Medial condyle of tibia.
16. Synovial membrane.

absent; at any rate, it is often difficult to find it. It arises at a variable point, and may arise in common with the superior branch. It accompanies the lateral popliteal nerve to the lateral angle of the popliteal fossa, and downwards over the

lateral head of the gastrocnemius; then, curving forwards, it passes between the capsule and the lateral ligament of the joint to supply its lower lateral part.

The recurrent nerve arises from the end of the lateral popliteal, in the substance of the peroneus longus. It pierces the extensor digitorum longus, and ascends through the tibialis anterior. Most of its fibres end in the tibialis anterior, but a fine twig or two reach the front of the joint.

The *medial popliteal nerve* (tibial) furnishes the knee joint with superior and inferior medial genicular branches and a middle genicular nerve, which are accompanied by the corresponding arteries.

The superior medial genicular nerve runs medially, above the medial femoral condyle, under cover of the semimembranosus and semitendinosus, pierces the posterior intermuscular septum, passes between the bone and the tendon of the adductor magnus, and sinks into the vastus medialis, through which it passes to the upper medial part of the joint.

The middle genicular nerve is short. It pierces the posterior ligament to supply the cruciate ligaments and their synovial covering.

The inferior medial genicular nerve descends to a lower level than the lateral nerve does, and is the largest of the articular nerves. It runs downwards and medially over the back of the joint, along the upper border of the popliteus, under cover of the medial head of the gastrocnemius, and then sweeps forwards below the medial condyle of the tibia, and, passing between the bone and the medial ligament of the joint, it finally turns upwards to supply the lower medial part of the capsule.

The branch from the *obturator nerve* descends through the substance of the adductor magnus, and, emerging from the muscle near the opening for the big vessels, it runs along the postero medial aspect of the popliteal artery as far as the back of the knee joint. At that point it leaves the artery and, inclining forwards, breaks up into several filaments which pierce the oblique posterior ligament separately.

Anastomosis around the Knee Joint.—The most important of the anastomoses around the knee joint are placed on the front of the joint, and take the form of three transverse arches.

The *upper* of these *arterial arcades* passes through the superficial fibres of the quadriceps extensor, close to the upper border of the patella

and is formed by the union of a branch from the superior lateral genicular artery with a twig from the descending genicular artery.

The middle and the lower transverse arches are both placed under cover of the ligamentum patellæ. The *middle arch* runs across in the fatty tissue just below the patella. It is formed by the inferior lateral genicular artery and a branch that results from the union of a twig from the descending genicular artery, and another from the superior medial genicular artery. The *lower arch* lies on the tibia, immediately above its tubercle, and results from the anastomosis of the anterior recurrent tibial and inferior medial genicular arteries.

The upper and middle of these arches are connected, on each side of the patella, by vertical channels ; and, thus, the patella is enclosed in an

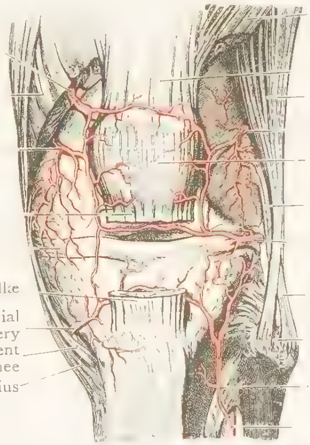


FIG. 168.—Anastomosis on the front of the Left Knee Joint.

irregularly quadrilateral arterial framework. From all sides of this arterial frame, twigs are given off which enter small foramina on the anterior surface of the patella to supply the osseous substance.

Six arteries, therefore, take part in the anastomoses on the front and sides of the joint, viz., the descending genicular artery, the two superior and the two inferior genicular arteries, and the anterior tibial recurrent artery. In addition to the twigs which proceed from these to form the arterial arches, numerous branches are given which spread over the bones in the form of a close meshwork. During the dissection of the joint these vessels will become apparent.

The back of the knee joint is supplied by twigs derived from all the genicular branches of the popliteal. These twigs are variable in their origin, and the anastomoses between them are inconstant. They are supplemented by the *posterior recurrent tibial*, which inosculates with the two inferior genicular arteries.

The *middle genicular artery* is destined chiefly for the supply of the interior of the joint. It pierces the oblique posterior ligament, passes forwards between the cruciate ligaments, and ramifies in the fatty tissue

in that situation. Its terminal twigs usually anastomose with the middle arch on the front of the knee joint. It will be dissected, at a later stage, in the interior of the joint.

> ***Dissection.***—Remove the popliteal vessels and nerves and the muscles surrounding the knee joint. Portions of the tendons of the biceps femoris, semimembranosus, sartorius, semitendinosus, gracilis, and popliteus, together with small pieces of the heads of the gastrocnemius, should be left in place in order that their connexions with the ligaments of the joint may be studied. The quadriceps femoris may be divided about three inches above the patella, and the distal part allowed to remain in position. Define the margins of the ligamentum patellæ.

External Ligaments. These are the capsular ligament, the oblique posterior ligament, the ligamentum patellæ, and the lateral and medial ligaments.

The **capsular ligament** is thin, wide and membranous at the back, thicker and narrower at the sides, and absent in front, where it is replaced not only by the patella but also by the ligamentum patellæ below the patella, and by the tendon of the quadriceps above the patella. Its *femoral* attachments are—(1) to the sides of the condyles a little distance (a quarter of an inch or rather more) from the articular margins; and (2) to the back of the femur, along the intercondylar line and just above the articular margins of the condyles. Its *tibial* attachments are—(1) to the posterior surfaces and the sides of the condyles a little distance (a quarter of an inch or less) below the articular margins; and (2) to the anterior surfaces of the condyles along oblique lines that begin near the articular margins of the sides and run to the sides of the tubercle of the tibia. At the back of the lateral condyle of the tibia, the lower part of the capsular ligament is perforated by the tendon of the popliteus; at the back of the medial femoral condyle there is sometimes a hole in the ligament through which the synovial membrane is continuous with the bursa under the medial head of the gastrocnemius. It is pierced also by the articular vessels and nerves.

The heads of the gastrocnemius and the plantaris overlie the posterior part of the capsule opposite the femoral condyles. The medial head is separated from the capsule of a bursa, but the lateral head and the plantaris are partly attached to it; and even the popliteus, after it emerges through the capsule, derives some fleshy fibres of origin from it.

The capsular ligament is supplemented and strengthened by accessory ligaments, by tendons or expansions from them,

and by deep fascia. The ligamentum patellæ (which is the tendon of the quadriceps) replaces it in front. The medial ligament of the joint overlies it on the medial side, and the lateral ligament on the lateral side. In the intervals that separate those two ligaments from the ligamentum patellæ, the

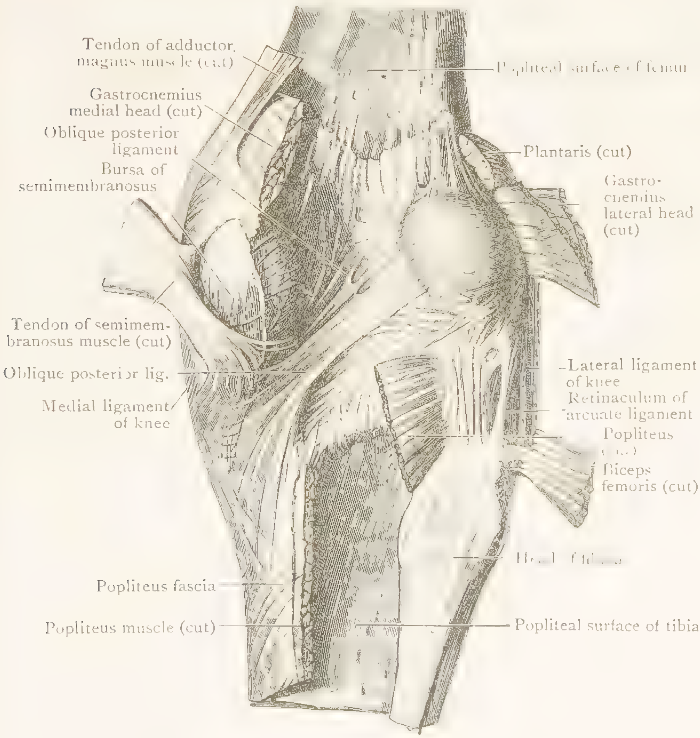


FIG. 169.—The Knee Joint. Posterior view.

capsule is subcutaneous and is strengthened by the fascia lata and expansions from the lateral and medial vasti which fuse with it. The expansions from the vasti are called the *patellar retinacula*. At the back, it is strengthened by the oblique posterior ligament.

The **oblique posterior ligament of the knee** (oblique popliteal) was found when the insertion of the semimembranosus was examined, and may be readily demonstrated if

the tendon of the semimembranosus is pulled upon. It is a broad slip that springs from that tendon at the back of the medial condyle of the tibia; it spreads upwards and laterally towards the lateral femoral condyle, fusing with the capsular ligament.

The *arcuate ligament* and its retinaculum are unimportant and variable thickenings of the back of the capsule between the head of the fibula and the lateral condyle of the femur.

The **ligamentum patellæ** is a strong, thick band, about two inches long and one inch wide. Its upper end is attached to the apex of the patella and to the lower part of the deep surface. Its lower end is attached to the smooth, upper part of the tubercle of the tibia. Its superficial fibres are directly continuous, over the surface of the patella, with the central part of the common tendon of the quadriceps femoris. The upper part of its deep surface is separated from the synovial membrane by a mass of loose fatty tissue called the *infrapatellar pad of fat*; the lower part is separated from the anterior surface of the upper end of the tibia by the deep infrapatellar bursa (Fig. 172).

FIG. 170.—The Lateral Ligament of the Knee Joint.

The **lateral ligament of the knee** (fibular collateral) is a rounded, cord-like band, nearly two inches long. It extends from the lateral epicondyle of the femur to the head of the fibula. Its upper part is fused with the underlying part of the capsule, but most of it is separated from the capsule by fatty tissue in which the inferior lateral genicular vessels and nerve lie. It is closely related to the tendon of the biceps femoris and the tendon of the popliteus. The tendon of the biceps overlies its lower part, and is first grooved by it and then split by it. The tendon of the popliteus takes origin from the femur below and in front of the attachment of the ligament. As the tendon runs downwards and backwards, it lies deep to the ligament, separated from it by the articular capsule.

The **medial ligament of the knee** (tibial collateral) is a long, flat band, broader in the middle than at its ends. It springs from the medial epicondyle of the femur, immediately below the adductor tubercle. As it descends, it inclines

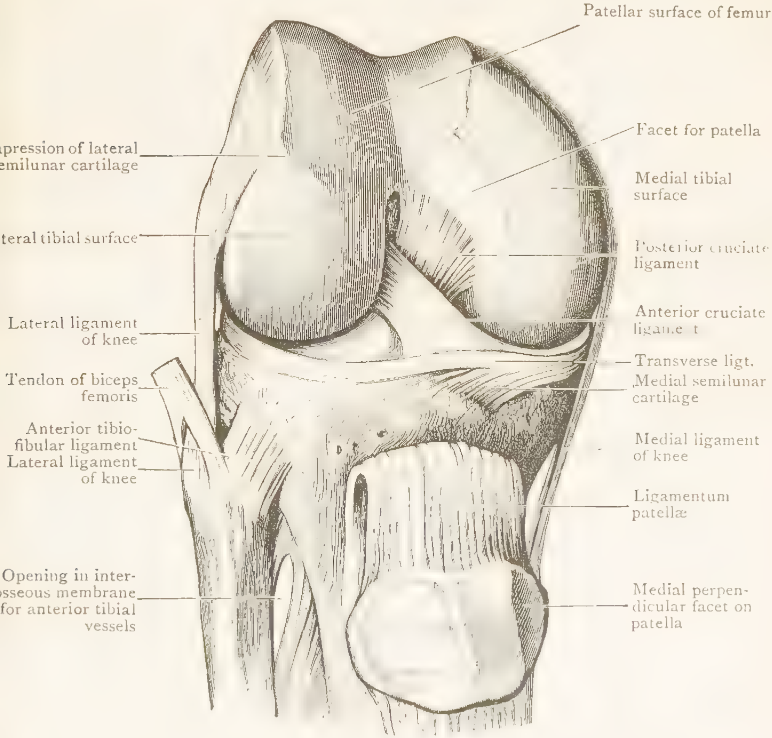


FIG. 171.—Dissection of the interior of the Knee Joint from the front.

slightly forwards, and it finally gains attachment to the margin of the medial condyle and to the upper fourth of the shaft of the tibia close to the medial border. Opposite the interval between the femur and the tibia, it is fused with the capsular ligament. The main part of the tendon of the semimembranosus extends forwards, under cover of its posterior border, to gain an insertion into the medial condyle of the tibia, whilst, lower down, the inferior medial genicular nerve

and vessels are carried forwards between it and the tibia. The tendons of the sartorius, gracilis, and semitendinosus overlie its lower part, but are separated from it by a bursa.

Dissection.—Make a transverse incision through the quadriceps femoris, immediately above the patella, and prolong each end of the incision downwards, about an inch and a half behind the patella, to the condyles of the tibia ; then turn the patella downwards.

The following structures can now be seen, viz., the *synovial membrane*, the *cruciate ligaments*, and the *semilunar cartilages.*

Next, split the lower part of the quadriceps, and turn the two parts aside, to expose the *deep suprapatellar bursa.* Open the bursa, if that was not done when the quadriceps was split. Explore the interior of the bursa and note the size of the opening by which it communicates with the knee joint.

Interior of the Joint.—First note the great pad of soft fat which is placed on the deep surface of the ligamentum patellæ, between the ligamentum and the synovial membrane (Fig. 172). It is termed the *infrapatellar pad.* It fills up the interval between the patella, femur, and tibia, and adapts itself to the varied forms which that recess assumes in the different movements of the joint. A triangular fold is pinched up from the synovial membrane that covers the back of the pad. The fold is called the *infrapatellar synovial fold.* From its apex, a narrow prolongation extends upwards and backwards to be attached to the anterior margin of the intercondylar notch of the femur. The lower parts of the margins of the fold are prolonged sideways as uneven ridges called the *alar folds.*

Synovial Membrane.—As the knee joint is the largest joint in the body, its synovial membrane is more extensive than that of any other joint. It lines the capsular ligament, and, at the bony attachments of that ligament, it is reflected on to the tibia and femur and extends to the margins of the articular cartilage, which it overlaps. It therefore covers the non-articular strips of bone that lie within the capsule.

At the sides, it is reflected also on to the upper and lower surfaces of the semilunar cartilages (menisci). Originally, those reflected portions covered the surfaces of these cartilages and met at their free edges ; but, in the adult, they thin out at the capsular margins of the cartilages and disappear, for they have been obliterated by pressure. In the middle part of the back of the joint, the synovial membrane is separated from the capsular ligament by the cruciate ligaments, for they

bulge it forwards into the cavity of the joint; the synovial membrane, therefore, covers the sides and the front of the cruciate ligaments, but leaves the posterior one to be connected with the capsular ligament by areolar tissue (Fig. 167); and this portion of the synovial membrane is connected with the femur and with the tibia around the attachments of the cruciate ligaments.

At the front of the joint, the synovial membrane is absent

FIG. 172.—Sagittal Section of the Right Knee Joint.

from the patella. Below the patella, it covers the posterior surface of the infrapatellar pad of fat, which separates it from the ligamentum patellæ; and it is raised up to form the infrapatellar and alar folds already described. Above the patella, it lines the deep surface of the tendon of the quadriceps extensor. A short distance above the patella, it is reflected off the tendon on to the fat that covers the front of the femur, and extends downwards to overlap the margin of the patellar articular surface of the femur. But the cavity of the joint communicates, by an opening of variable width, with the deep suprapatellar bursa. That bursa is, in effect, an extension

of the synovial membrane ; and the upper limit of the cavity of the joint is therefore about three finger-breadths above the patella, when the joint is in the extended position.

In many subjects, the synovial membrane is continuous with the bursa of the medial head of the gastrocnemius through a hole in the back of the capsule. A tube-like pouch of the synovial membrane lies along the medial side of the intracapsular part of the tendon of the popliteus. The pouch separates the tendon from the lateral condyle of the femur and the margin of the lateral semilunar cartilage (Fig. 167), and may overlap the edges of the tendon ; it is carried out of the joint with the tendon, and separates the tendon from the back of the lateral condyle of the tibia and from the back of the superior tibio-fibular joint, with which it sometimes communicates.

Dissection. — Divide the infrapatellar synovial fold and remove the infrapatellar pad of fat. Open and examine the bursa between the ligamentum patellæ and the tibia. Then, turn the limb round, dissect away the intermediate part of the posterior portion of the capsule, and trace the middle genicular artery (which pierces it) forwards to the cruciate ligaments.

Remove the areolar tissue from the back of the cruciate ligaments, and the synovial membrane from their front and sides ; and define their attachments to the femur and tibia. Then, define the connexions of the semilunar cartilages.

At this stage, the changes produced in the degree of tension of the cruciate ligaments, and the change in the position of the semilunar cartilages (menisci) brought about by movements of the joint, should be examined.

Movements at the Knee Joint. The chief movements at the knee joint are flexion and extension. The leg can be bent backwards until the calf comes into contact with the back of the thigh ; but in extension the movement is brought to a close when the leg comes into a line with the thigh. In that position the joint is firmly locked ; the anterior cruciate, the medial and lateral ligaments, and the posterior part of the capsule with the oblique posterior ligament are taut ; and the leg and thigh are converted into a rigid column of support. In flexion, however, the ligaments mentioned are relaxed, and a considerable amount of rotation is allowed, which is most free when the leg is at right angles to the thigh.

The muscles which operate are :—*Extensors* : the four parts of the quadriceps femoris. *Flexors* : biceps femoris,

popliteus, sartorius, gracilis, semitendinosus, and semimembranosus. Of these, only one is inserted on the lateral side of the limb, viz., the biceps. The other five are inserted into the tibia on the medial side of the leg.

Medial rotators: Popliteus, gracilis, sartorius, semitendinosus, and semimembranosus. *Lateral rotator*: biceps femoris.

Flex the joint acutely, and examine the articular surface of the distal end of the femur. It consists of an anterior trochlear portion for the patella, and two condylar surfaces which move on the semilunar cartilages and tibia. The trochlea is separated from the surface of the lateral condyle by a faintly marked groove, which takes a slightly curved course, from the lateral border of the distal end of the femur, medially and backwards to the fore part of the intercondylar notch. At each extremity this groove widens out into a distinct depression. In full extension the lateral depression rests upon the anterior part of the lateral semilunar cartilage, whilst the medial depression rests against the anterior border of the lateral intercondylar tubercle of the tibia (Bruce Young). The line of demarcation between the trochlea and the distal surface of the medial condyle is not so distinct. Close to the medial margin of the bone there is a depression which, in full extension, rests upon part of the anterior horn of the medial semilunar cartilage (Bruce Young): but, lateral to this, the trochlear surface is prolonged backwards for a certain distance along the anterior and medial margin of the intercondylar notch. A portion of the medial condyle is thus included in the trochlear surface, viz., the portion skirting the medial border of the anterior part of the intercondylar notch, and this is termed the "crescentic facet" of the condyle.

Now, examine the posterior surface of the patella (Fig. 171), and study its movements in connection with flexion and extension of the knee. A high vertical ridge divides the posterior surface into a large lateral and a smaller medial area. Each of these is still further subdivided by faint ridges on the cartilage which coats the surface. A faint line upon the medial area of the patella descends in a vertical direction so as to mark off a narrow strip close to the medial border of the bone. This strip is called the *medial perpendicular facet*. Two horizontal lines extend laterally from the medial perpendicular facet to the lateral border of the bone, and subdivide the remainder of the medial area and the whole of the lateral area into three facets each. In a well-marked patella, therefore, its articular surface shows seven facets, viz., a proximal pair, a middle pair, a distal pair, and a medial perpendicular facet (Goodsir).

The faceted appearance of the posterior surface of the patella indicates that, in the movements of that bone upon the trochlear surface of the femur, the entire articular surface is never in contact with the femur at the same time. In flexion and extension of the knee, the patella moves downwards and upwards in a curved path, the concavity of which looks upwards, backwards, and laterally. The different facets come smoothly into contact and break contact with the femur in regular succession. Let us suppose the knee joint to be acutely flexed: in that condition of the limb the medial perpendicular facet of the patella rests upon the crescentic facet of the medial condyle of the femur, while the lateral of the two proximal patellar facets is in contact with the lateral lip of the trochlear surface of the femur. No part of the patella touches the medial lip of the trochlear surface. As the leg is moved from the fully flexed

to the fully extended position, the two proximal facets, then the two middle facets, and, lastly, the two distal facets, come successively into contact with the trochlear surface of the femur (Goodsir). In Figs. 174, 175, 176 B, the varying positions of the patella, as seen by X-rays, are exhibited.

Now examine the condylar surfaces of the femur (Fig. 171). The posterior two-thirds of the medial condyle will be seen to be of equal extent with, and parallel to, the lateral condyle. The anterior third of the medial condyle, however, turns obliquely laterally to join the trochlear surface. The lateral condylar surface has no corresponding part. The obliquely directed part of the medial condyle gives rise to the "screw-home" movement, which is so characteristic of the knee joint when fully extended. At the commencement of flexion and at the completion of extension there is a screw movement, or a movement of rotation of the tibia and femur on each other. As the leg is moved forwards from the condition of acute flexion, the condyles of the femur roll and glide over the surfaces of the semilunar cartilages and the proximal end of the tibia until the surface of the lateral condyle, and the corresponding part of the medial condyle, are exhausted. This movement of the femoral condyles has been compared to that of "a wheel partially restrained by a drag" (Goodsir). Any additional movement must necessarily take place in connexion with the anterior, oblique third of the medial condyle, and the result is a rotation or screw-like motion of the femur medially. The medial condyle travels backwards round the intercondylar eminence of the tibia, and the anterior part of the intercondylar notch comes into contact with the anterior cruciate ligament and the medial intercondylar tubercle (Bruce Young). The joint is now "screwed home" or locked. In the initial stage of flexion the reverse movement must be accomplished. The joint can be unlocked only by a rotation medially of the tibia or a rotation laterally of the femur—brought about by the popliteus.

When fully extended, the joint is locked, and the posterior part of the capsule, the collateral ligaments, and the anterior cruciate ligaments are tense. The limb is converted into a rigid column, and the upright posture is thereby maintained with the smallest possible degree of muscular exertion.

Dissection.—In order to obtain a proper view of the attachments of the cruciate ligaments, make the following dissection: Saw the femur across about two inches above its distal articular surface. Then, divide the distal part of the bone by a sagittal saw-cut that ends in the intercondylar notch between the two cruciate ligaments.

The cruciate ligaments can, at this stage, be studied singly, or together, and their relation to the ligaments at the sides of the joint can be examined. The lateral ligament of the joint and the anterior cruciate ligament are fixed to opposite sides of the lateral condyle. The medial ligament and the posterior cruciate ligament are attached to the opposite sides of the medial condyle. When that relationship has been noted, divide the medial ligament of the joint, in order to free the medial condyle, and give greater space for the study of the cruciate ligaments.

Cruciate Ligaments of the Knee.—The cruciate liga-

ments are well named, because they cross each other like the limbs of the letter X. This cruciate arrangement is seen whether they are viewed from the side, after removal of the distal part of one condyle, or from the front or the back of the joint.

The *anterior cruciate ligament* springs from the anterior

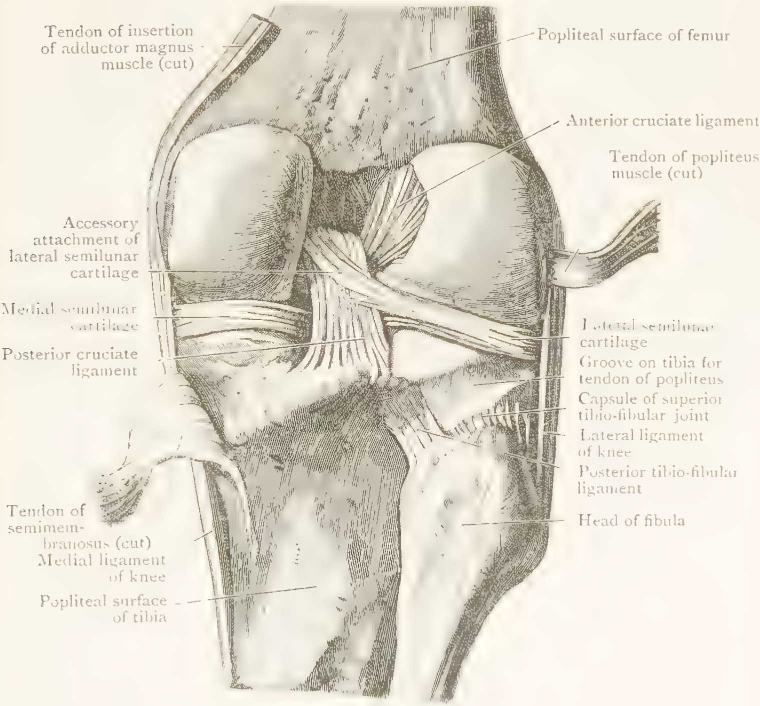


FIG. 173.—The Knee Joint opened from behind by the removal of the Posterior part of the Capsule.

part of the intercondylar area on the upper surface of the tibia, and proceeds upwards, backwards, and laterally, to gain attachment to the posterior part of the medial surface of the lateral condyle of the femur (Fig. 173).

The *posterior cruciate ligament* springs from the posterior part of the intercondylar area. It passes upwards, forwards, and a little medially, and, crossing the anterior cruciate

ligament obliquely, is attached to the anterior portion of the lateral surface of the medial condyle. It receives one, or sometimes two, strong slips from the posterior horn of the lateral semilunar cartilage (meniscus) (Fig. 173).

The anterior cruciate ligament is tight *in extension* of the knee joint, and the posterior *in flexion*.

Semilunar Cartilages. — The semilunar cartilages (menisci) are two crescentic plates of fibro-cartilage which are placed on the condylar surfaces of the tibia. Each has two fibrous extremities or *horns*, which are attached to the rough, intercondylar area on the proximal surface of the tibia. The semilunar cartilages deepen the surfaces upon which the condyles of the femur roll, and, being movable, they fill up the gaps which would otherwise arise during the movements of the joint. They are thick towards the circumference of the joint, but thin away to a fine, free, concave edge towards the centre. Both surfaces are smooth and articular. They do not cover the entire extent of the condylar surfaces of the tibia. The central parts of those surfaces, as well as the sloping surfaces of the tubercles of the intercondylar eminence, are free. When the cartilages are raised from the surface upon which they rest, distinct impressions, similar in shape and extent, are seen on the subjacent encrusting cartilage of the tibia.

> ***Dissection.*** Carefully define the attachments of the fibrous horns of the semilunar cartilages.

The **lateral semilunar cartilage** is usually rather thicker around its circumference than the medial one is. It forms the segment of a smaller circle, and its horns being fixed to the tibia close together, a very nearly complete circle is formed. The *anterior horn* is attached to the tibia immediately in front of the intercondylar eminence, lateral to the anterior cruciate ligament, and partly under cover of it. The *posterior horn* is fixed to the summit of the intercondylar eminence. It gives a strong slip also to the posterior cruciate ligament.

The lateral ligament of the knee is separated from the lateral semilunar cartilage by the capsular ligament and by the tendon of the popliteus and its synovial pouch. The tendon grooves the posterior part of the lateral border of the cartilage, but behind and in front of the groove the peripheral margin of the cartilage is blended with the capsular ligament.

PLATE XXV

The union

PLATE XXVI

FIG. 175A.—Lateral Radiograph of same Knee as in Fig. 174, in extension. Note the areas of contact of the Femur with the Patella and Tibia; also the sesamoid bone (Fabella) in the lateral head of the

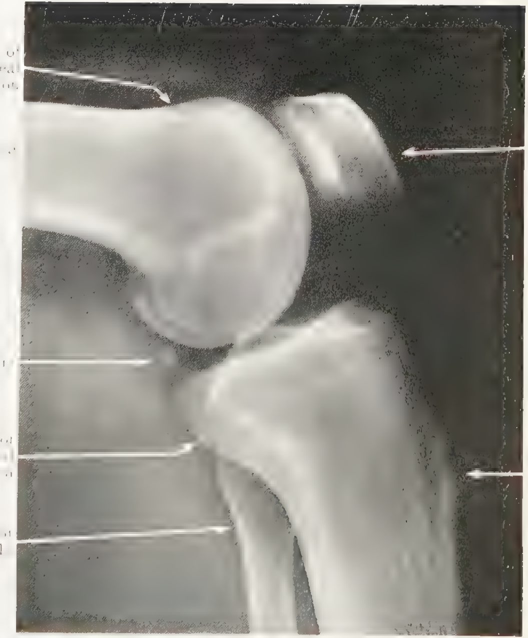
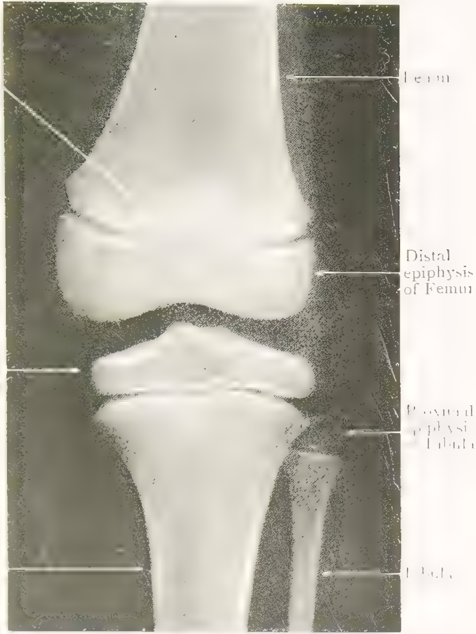
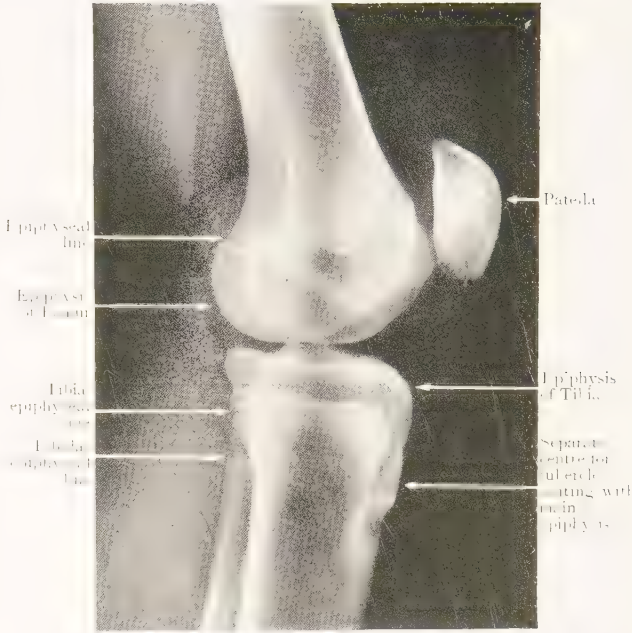


FIG. 175B. Lateral Radiograph of the same Knee, semi-flexed. Note the change in the areas of contact of the Femur with the Patella and Tibia.



[illegible] J. Duncan White.)



[illegible] Radiograph of slightly flexed Knee of girl aged 12. (Dr. J. Duncan White.) Note the "doubling" of the femoral epiphyseal line, and the extension of the tibial epiphysis to the tubercle, probably ossified in th[illegible] separate centre.

PLATE XXVIII

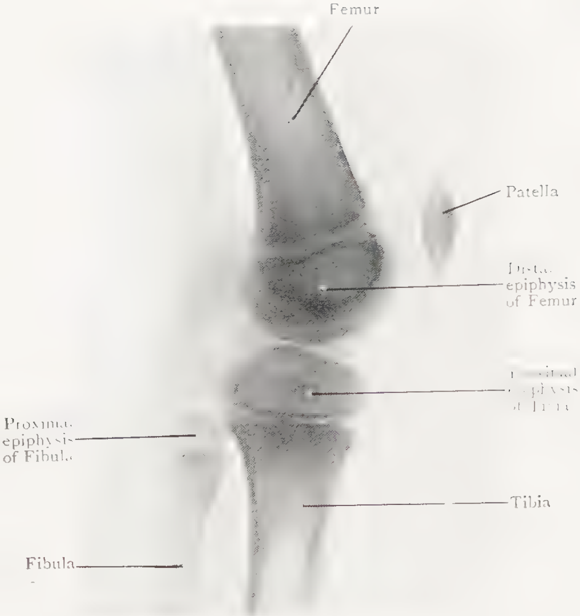


FIG. 177A.—Lateral Radiograph of Knee of boy aged 7.
(Dr. J. M. Woodburn Morison.)

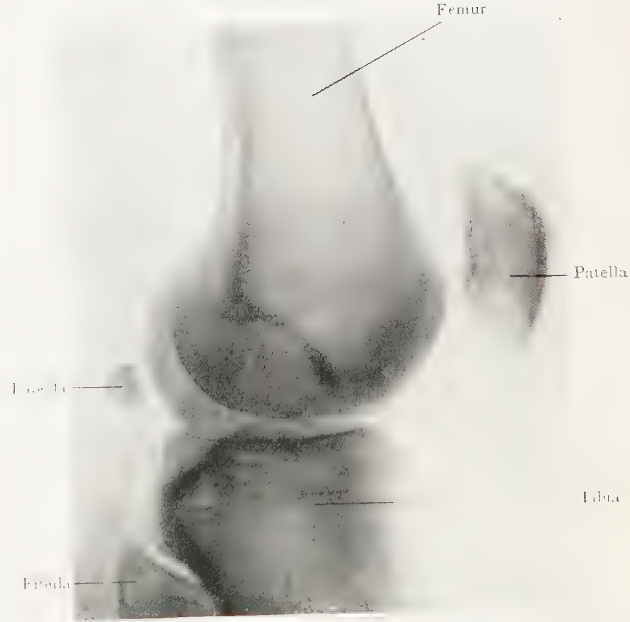
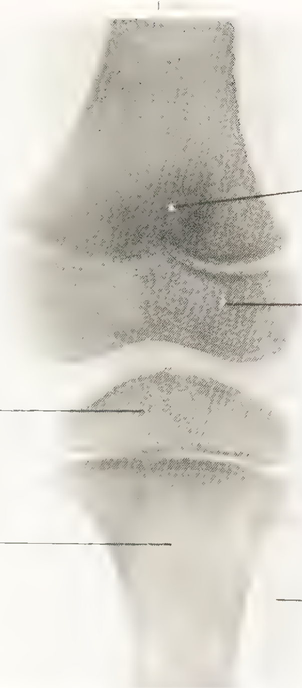


FIG. 177B.—Lateral Radiograph of extended Knee of an adult.
(Alexis Thomson.)

Note the relations of the Femur to the Patella and the Tibia, and the sesamoid bone (Fabella) in the lateral head of the gastrocnemius.

PLATE XXIX



iograph of Knee of boy aged 7
M. Woodburn Morison.)

—Radiograph of Knee of boy aged 15½.
(Dr. J. M. Woodburn Morison.)

PLATE XXX

FIG. 170A.—Ant. post. Radiograph of Ankle and Tarsus of young man aged 22. (Dr. J. Duncan White.) Note that the superimposition of the tarsal bones

FIG. 170B.—Lateral Radiograph of the same Ankle and Tarsus. (Dr. J. Duncan White.)

The **medial semilunar cartilage** is semicircular in outline, and forms the segment of a much larger circle than the lateral one does. Its *anterior horn* is fixed to the anterior part of the intercondylar area, in front of the attachment of the anterior cruciate ligament. Its *posterior horn* is attached in the intercondylar area, behind the intercondylar eminence and in front of the attachment of the posterior cruciate ligament. The greater part of the peripheral border of the medial semilunar cartilage is closely connected with the capsular ligament.

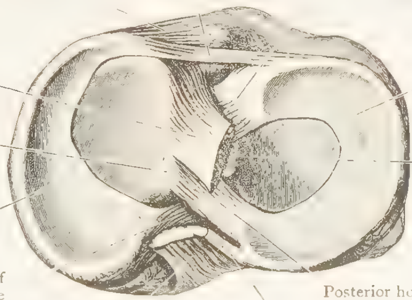


FIG. 180.—Parts attached to the proximal surface of Right Tibia.

Through their connexions with the capsular ligament both the semilunar cartilages gain attachment to the distal end of the femur and the proximal end of the tibia.

The **transverse ligament of the knee** is a fibrous band which stretches across from the anterior part of one semilunar cartilage to the corresponding part of the other.

Dissection.—Detach the condyles of the femur by dividing the lateral ligament, the cruciate ligaments, and the remains of the capsular ligament close to their femoral attachments.

Attachment of Parts to Proximal Surface of Tibia.

The ligaments and the semilunar cartilages (menisci) are attached to the intercondylar area in the following order from before backwards :—

1. The *anterior horn of the medial cartilage*, on the medial part of the extreme anterior part of the area.
2 and 3. The *anterior cruciate ligament* and the *anterior horn of the lateral semilunar cartilage*: these are placed side by side, but the attachment of the ligament, which lies to the medial side, overlaps that of the horn.
4. The *posterior horn of the lateral cartilage*, on the summit of the intercondylar eminence between its two tubercles.
5. The *posterior horn of the medial cartilage*, immediately behind the intercondylar eminence.
6. The *posterior cruciate ligament*, at the posterior part of the area.

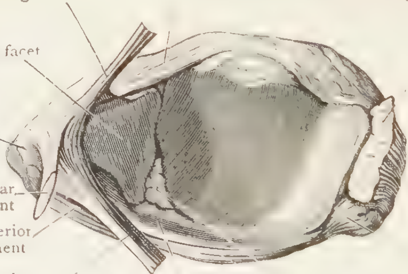


FIG. 181.—Articular Surfaces of Tibia and Fibula which articulate with the Talus.

Ankle Joint (Articulatio Talocruralis)

The ankle joint is a synovial joint of the hinge variety. It is a joint of great strength; its stability is ensured not only by its powerful ligaments and the tendons around it, but also by the close interlocking of the articulating surfaces.

The bones which enter into the formation of the ankle joint are the talus and the distal ends of the tibia and fibula. The talus articulates with the bones of the leg by three of its surfaces upper, medial and lateral. The distal ends of the leg bones are very firmly united together by interosseous and other ligaments, but these ligaments give to the joint a certain amount of elasticity or spring. The bones form a deep hollow or socket that resembles a mortice, and the upper part of the talus is received into the cavity (Fig. 182). The socket is slightly deepened posteriorly by the *transverse tibio-fibular ligament* (Figs. 181, 183), which springs from the fossa of the

lateral malleolus and widens to be attached to the posterior border of the distal end of the tibia.

Dissection.—Remove the remains of the flexor and extensor retinacula, and cut through and displace the tendons which are in relation with the joint, but do not remove them. Then,

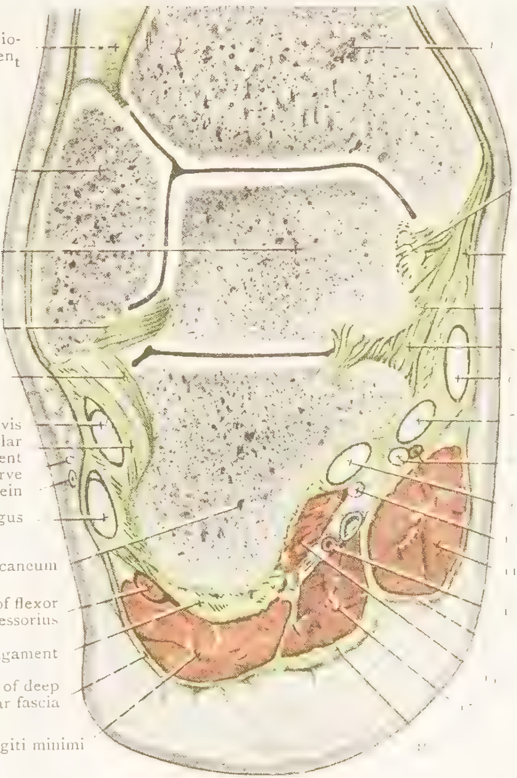


FIG. 182.—Oblique Coronal Section through the Ankle and Talo-Calcanean Joints.

1. Tibia.
2. Deep fibres of deltoid ligament.
3. Superficial fibres of deltoid ligament.
4. Deep fibres of deltoid ligament.
5. Deep fibres of deltoid ligament continuous with interosseous talo-calcanean ligament.
6. Tibialis posterior.
   Flexor digitorum longus.
8. Medial plantar nerve and artery.
9. Flexor hallucis longus.
10. Lateral plantar nerve.
11. Abductor hallucis.
12. Lateral plantar artery.
13. Medial part of deep plantar fascia.
14. Medial head of flexor accessorius.
15. Flexor digitorum brevis.
16. Plantar aponeurosis.

endeavour to trace out the anastomoses between the arteries around the joint (p. 352), and if possible secure the twigs from the anterior and posterior tibial nerves which supply the joint.

FIG. 183.—Ankle Joint dissected from behind, with part of the Articular Capsule removed.

Ligaments of Ankle Joint.—These are :—

Capsular ligament.
- Deltoid (medial) ligament.
- Anterior ligament.
- Posterior ligament.
- Lateral ligament—
  - Anterior talo-fibular ligament.
  - Posterior ,, ,,

Calcaneo-fibular ligament.

Dissection.—Pull aside the remains of the arteries and nerves, and clean carefully the anterior and posterior ligaments of the joint, both of which are extremely thin and easily injured. When their attachments and relations have been demonstrated, remove them in order to bring the ligaments on the medial and lateral sides of the joint more fully into relief.

Capsular Ligament.—The anterior, posterior, lateral and medial ligaments are joined together by their edges, and form a complete capsular ligament around the joint. The medial ligament is greatly thickened and is called the deltoid ligament. Two bands, called the *anterior* and *posterior talo-fibular ligaments* are laid on the surface of the lateral ligament

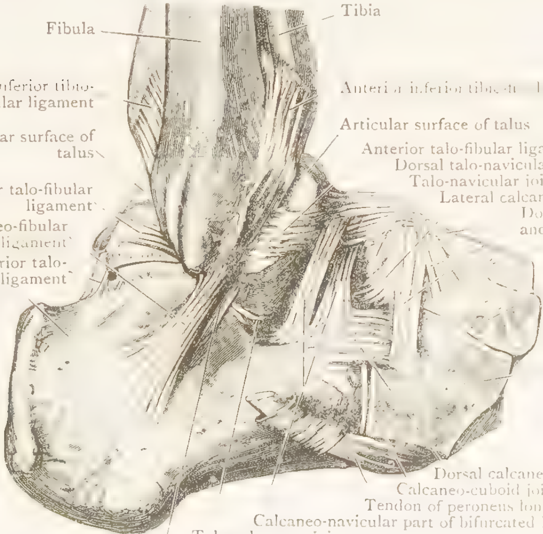


FIG. 184.—Ligaments on the Lateral Aspect of the Ankle Joint and on the Dorsum of the Tarsus.

and are fused with it, and may be regarded as thickenings of its substance. The *calcaneo-fibular ligament* is not part of the capsule; it is situated on the lateral side of the joint, and is separated from the lateral ligament by fatty tissue.

The **anterior ligament** of the ankle joint, thin, wide and membranous, is composed chiefly of transverse fibres. It extends from the anterior margin of the distal surface of the tibia to the anterior part of the dorsal surface of the neck of the talus. Therefore, a cut across the foot, immediately in front of the tibia, will open the ankle joint (see Fig. 186).

The **posterior ligament** also is composed chiefly of tran- [illegible]

to define it, and it is often incomplete. It extends from the posterior border of the distal end of the tibia and the transverse tibio-fibular ligament to the posterior border of the talus.

The **medial** or **deltoid ligament** is so strong that, when strain is put on the medial side of the joint, the ligament may tear off the malleolus rather than itself be torn. It springs

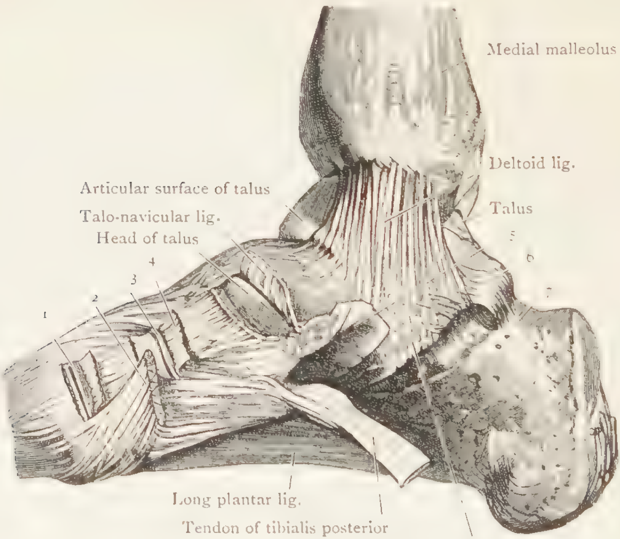


FIG. 185.—Ankle and Tarsal Joints from the Medial Side.

1. First tarso-metatarsal joint (opened).
2. Tendon of tibialis anterior (cut).
3. Medial cuneo-navicular joint (opened).
4. Dorsal cuneo-navicular ligament.
5. Groove on spring ligament for the tendon of tibialis posterior.
6. Groove and tunnel for the tendon of flexor hallucis longus.
7. Calcaneum.

from the lower border of the medial malleolus and radiates to: (1) the tuberosity of the navicular bone, (2) the edge of the "spring" ligament, (3) the neck of the talus, (4) the sustentaculum tali, and (5) the body of the talus—in that order from before backwards. Its attachment to the spring ligament is an important connexion and should be specially examined. The deltoid ligament braces up the spring ligament and helps it to support the head of the talus and to preserve the arch of the foot.

The **lateral ligament** is a curved, narrow band composed of short fibres loosely arranged. Its edges are attached to the margins of the facet of the lateral malleolus and the margins of the facet on the lateral surface of the talus. It is fused with the talo-fibular ligaments.

The *anterior talo-fibular ligament* is a flattened band which passes forwards from the anterior border of the lateral malleolus to the neck of the talus immediately in front of the fibular facet (Figs. 181, 184).

The *posterior talo-fibular ligament* is much stronger. It runs almost horizontally, medially and backwards, from the fossa of the lateral malleolus to the posterior tubercle of the talus (Figs. 181, 182, 184).

Generally in the child, and sometimes in the adult, the posterior tubercle is a separate piece of bone, attached to the talus by a layer of cartilage and the surrounding periosteum. In such cases it forms a supernumerary tarsal bone which represents the *os trigonum* found in some mammals. If this fact is not kept in mind, a fracture of the talus may be diagnosed when the separate bone is seen in a radiograph of an injured ankle (Figs. 189, 190).

The **calcaneo-fibular ligament** is a round, cord-like band which passes from the distal end of the lateral malleolus to the lateral surface of the calcaneus (Figs. 181, 182, 184).

Synovial Membrane.—The synovial membrane lines the capsular ligament, and sends a narrow process upwards to line the ligaments of the inferior tibio-fibular joint. It is thrown into a transverse fold anteriorly when the joint is flexed, and into a similar fold posteriorly when the joint is extended.

Relations.—Before the further examination of the joint is proceeded with, replace the tendons, vessels, and nerves and note their relations to the articular capsule.

Anteriorly, from the medial to the lateral side, lie the tibialis anterior, the extensor hallucis longus, the anterior tibial vessels and nerve, and the extensor digitorum longus with the peroneus tertius. The perforating branch of the peroneal artery descends across the anterior talo-fibular ligament lateral to the peroneus tertius (Fig. 143, p. 318).

Behind the joint, from the medial to the lateral side, the structures in close relation with the capsule are: the flexor digitorum longus, the posterior tibial vessels and nerve, the flexor hallucis longus, and the peroneal artery. Farther back, separated from the flexor hallucis longus by a large pad of fat, there is the tendo calcaneus.

On the medial side, the tibialis posterior lies on the deltoid ligament, and the flexor digitorum longus lies on the attachment of that ligament to the sustentaculum tali. *On the lateral side*, the peroneus longus and brevis cross the calcaneo-fibular ligament.

Dissection.—Cut through the anterior talo-fibular ligament, the calcaneo-fibular ligament, and the greater part of the deltoid ligament; separate the articular surfaces and examine them.

The Articular Surfaces of the Ankle Joint.—The proximal articular area is formed by the talar surfaces of the tibia and the malleoli. These three surfaces together form the boundaries of a socket. It is important to note that the socket is wider in front than it is behind. The distal articular area is formed by the upper surface of the body of the talus and the articular parts of its medial and lateral surfaces. It also is broader in front than behind; and it fits into the socket formed by the bones of the leg. When the joint is dorsi-flexed—that is, when the foot is turned upwards—the broad part of the distal articular area rotates backwards into the narrow part of the socket and the joint becomes locked. When the joint is plantar-flexed—that is, when the foot is turned downwards—the narrow part of the distal articular area moves forwards into the wide part of the socket, and a small amount of side to side movement becomes possible.

Movements.—The movements which take place at the ankle joint are—(1) dorsi-flexion; (2) plantar-flexion or "extension"; and (3) a very limited degree of lateral movement when plantar-flexion is complete. The two principal movements take place around a horizontal axis, which is not transverse, but inclines backwards as it passes from medial to lateral side, forming an angle of about 60° with the median plane (Krause). This horizontal axis passes through or near the interosseous canal between the calcaneum and talus (Henle). As the articular surfaces are broader in front than behind, it follows that the more completely the ankle joint is dorsi-flexed, the more tightly will the talus be grasped between the two malleoli. In the erect position, the talus is held firmly in the bony socket, and portions of its articular surface project both in front of and behind the tibia. The line of the centre of gravity falls in front of the ankle joint, and as a result the bones are kept firmly locked. When, on the other hand, the ankle joint is fully plantar-flexed (as when we rise on tiptoe) the narrower posterior part of the talus is brought into the socket, and thus a limited amount of movement sideways is allowed. In *dorsi-flexion*, the calcaneo-fibular and posterior talo-fibular bands, the greater part of the deltoid ligament, and the posterior part of the capsule are put on the stretch. In *plantar-flexion*, the anterior talo-fibular ligament, the anterior fibres of the deltoid ligament, and the anterior part of the capsule are tense.

The **muscles** principally concerned in producing *dorsi-flexion* are the

tibialis anterior, the extensor digitorum longus, the extensor hallucis longus and the peroneus tertius; the *plantar-flexors* are the superficial muscles of the calf, the tibialis posterior, the long flexors of the toes, and the peroneus longus and brevis.

Tibio-fibular Joints.

The fibula articulates with the tibia by both of its extremities. The *superior tibio-fibular joint* is a synovial joint. The *inferior joint* is a syndesmosis—that is, the bones are held together by ligaments that do not enclose a cavity, and the only movements possible are those allowed by slight stretching and twisting of the ligaments. The interosseous membrane is common to both joints.

Dissection.—Preparatory to the examination of the tibio-fibular joints, remove the foot by dividing the remains of the ligaments of the ankle joint. Clean and define the ligaments that connect the ends of the fibula with the tibia. Detach the muscles from the bones of the leg and from both surfaces of the interosseous membrane, and clean the membrane.

The **interosseous membrane** is a strong membrane which stretches across the interval between the tibia and the fibula, and greatly extends the surface for the origin of muscles. It is attached to the interosseous borders of the two bones. It is composed of strong, oblique fibres which run downwards and laterally from the tibia to the fibula. In the upper part of the membrane, immediately below the lateral condyle of the tibia, there is an oval opening for the passage of the anterior tibial vessels, whilst a small aperture, a short distance above the ankle joint, transmits the perforating branch of the peroneal artery. The membrane is supplied by a branch from the nerve to the popliteus.

Superior Tibio-fibular Joint. At this joint, the head of the fibula articulates with the lateral condyle of the tibia. The bones are united by a capsular ligament attached near the margins of the articular facets. This capsule is strengthened, in front and behind (especially in front), by oblique fibres that run downwards and laterally from the tibia to the head of the fibula. The tendon of the popliteus and its synovial pouch cross the upper part of the back of the joint, and the pouch sometimes is continuous with the synovial membrane of the joint through a hole in the capsule; in this way the joint is indirectly in communication with the knee joint. The

lateral ligament of the knee and the tendon of the biceps cross the upper surface of the joint ; and some fibres of the tendon of the biceps extend to the tibial condyle, constituting an additional ligament of the joint. The uppermost fibres of the peroneus longus and extensor digitorum longus spring from the lateral condyle of the tibia, and cross the front of the joint.

The joint is supplied by twigs from the nerve to the popliteus and the recurrent genicular nerve.

Inferior Tibio-fibular Joint (Figs. 181-184).—This joint is constructed upon a stronger plan, because the

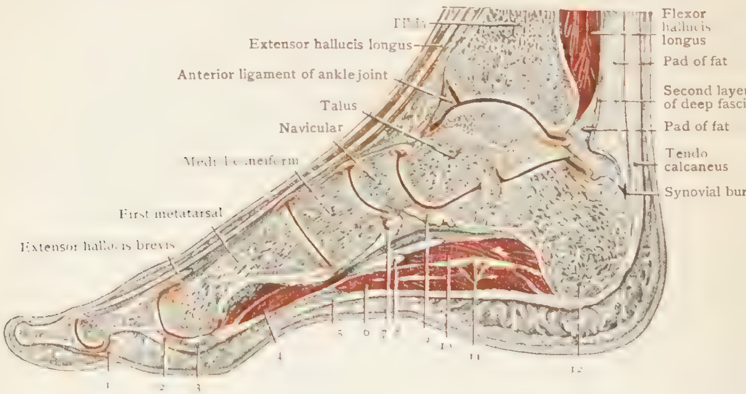


FIG. 186.—Oblique sagittal section through the Foot, along a plane extending from the middle of the heel to the middle of the big toe.

1. Flexor hallucis longus.
2. Plantar metatarso-phalangeal lig.
3. Sesamoid bone.
4. Flexor hallucis brevis.
5. Plantar fascia.
6. Flexor digitorum brevis.
7. Tibialis posterior tendon.
8. Flexor digitorum longus tendon.
9. Plantar calcaneo-navicular lig.
10. Flexor accessorius.
11. Lateral plantar vessels and nerve.
12. Calcaneum.

strength of the ankle joint very largely depends upon its integrity.

The joint is formed by the fibula and the distal end of the tibia. The bones are not in contact with each other, for the interosseous ligament separates them as well as binds them. But sometimes the interosseous ligament does not quite reach the lateral border of the distal end of the tibia. In such cases, there is a narrow strip above the lateral border which is coated with cartilage for articulation with the uppermost part of the facet of the lateral malleolus.

PLATE XXXI

Lateral Radiograph of the same Ankle and Foot.

epiphysis of the Calcaneum.

PLATE XXXII

Fig. 188.—Radiograph of Foot of child aged 6.

Note that the ossification of the epiphysis of the Calcaneum has just begun and that there is no indication of the os trigonum (see Fig. 189).

PLATE XXXIII

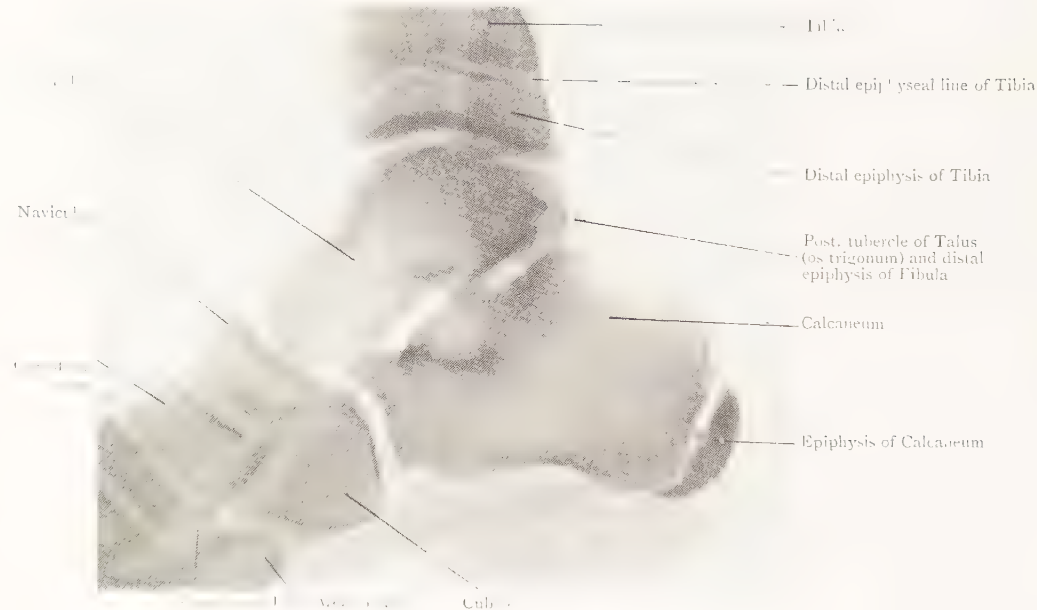


FIG. 180.—Radiog: ph of Foot of child a

. . . there is a separate centre for the . . . ; it may . . . separate as the os trigonum. The . . .

PLATE XXXIV

FIG. 190.—Lateral Radiograph of Foot of girl aged 17.

(Dr. J. Duncan White.)

The ligaments of the joint are :—

1. The interosseous.
2. Anterior inferior tibio-fibular.
3. Posterior inferior tibio-fibular.
4. Transverse tibio-fibular.

The **interosseous ligament** is the chief bond at this joint. It is thick and very strong, and is composed of short fibres that pass from the rough patch above the facet of the lateral malleolus to the floor of the fibular notch of the distal end of the tibia.

The **anterior inferior** and **posterior inferior tibio-fibular ligaments** (anterior and posterior ligaments of lateral malleolus) are strong, flat bands that pass upwards and medially from the front and the back of the uppermost part of the lateral malleolus to the distal end of the tibia. They conceal the interosseous ligament. The posterior ligament is continuous inferiorly with the transverse ligament.

The **transverse tibio-fibular ligament** is a strong, narrow band of yellowish fibres attached to the whole length of the posterior border of the distal surface of the tibia and to the malleolar fossa of the fibula. It projects downwards as a lip from the posterior border of the socket of the ankle joint (Figs. 181, 183) and articulates with a special facet of the talus.

Dissection.—To see the interosseous ligament, saw across the bones of the leg about two inches from the distal end of the tibia, and then split them by a coronal saw-cut. The short, strong fibres of the interosseous ligament will then be seen, and also the short, narrow articular interval between the distal portions of the bones, when that interval is present.

Joints of the Foot.

The joints of the foot are very numerous. All the bones of the foot—tarsal and metatarsal bones and phalanges—enter into their formation ; and they are classified therefore as :—

1. Intertarsal joints.
2. Tarso-metatarsal joints.
3. Intermetatarsal joints.
4. Metatarso-phalangeal joints.
5. Interphalangeal joints.

Arches of the Foot.—The tarsal and metatarsal bones are bound together by interosseous, plantar, and dorsal ligaments, and are disposed in the form of two arches, viz., a longitudinal and a transverse. The integrity of the arches is maintained : (1) partly by the shape of the bones ; (2) partly by the tension of the ligaments ; (3) partly by the support

of tendons ; and (4) partly by the tension of the plantar aponeurosis.

The **longitudinal arch** presents a greater height and a wider span along the medial side of the foot than along the lateral side. The talus lies at the summit of this arch and forms its keystone. The *posterior pillar* is short and solid, being formed by the calcaneum alone. The *anterior pillar*, much longer, is composed of several bones, viz., the navicular, the cuboid, the three cuneiforms, and the metatarsus. Further, the anterior pillar is divided into a medial column composed of the navicular, the three cuneiform, and the medial three metatarsal bones, and a lateral column composed of the cuboid and the lateral two metatarsal bones.

The weight of the body is transmitted to the summit of the arch through the talus, and the most important ligaments concerned in the prevention of flattening of the arch lie in the plantar concavity ; they are the *plantar calcaneo-navicular ligament* (" spring "), the *long plantar ligament* and the *short plantar ligament*. The various slips of the *tendon of the tibialis posterior*, as they pass to find attachment to the different tarsal and metatarsal bones, give additional support, as also does the *tendon of the peroneus longus*, which crosses the foot obliquely from lateral to medial side. The *plantar aponeurosis* is also an important factor, for, as it extends between the two pillars and is attached to both, it operates, as the late Sir George Humphry once pointed out, in the same manner as the " tie-beam " of a roof.

The **transverse arch** of the foot is seen to best advantage across the line of the tarso-metatarsal articulations.

> ***Dissection.***—Remove all the muscles and tendons from the tarsus and metatarsus. Clean and define the ligaments on the various surfaces.

Joints of the Talus. The talus articulates with the bones of the leg by its upper surface and its sides. Its lower surface articulates with the calcaneum and the plantar calcaneo-navicular ligament (spring ligament). Anteriorly, its head articulates with the navicular bone. It takes part, therefore, in three joints, namely—the *ankle* joint, the *talo-calcanean* joint and the *talo-calcaneo-navicular* joint. The ligaments that hold it in its place are (1) the capsular ligament of the ankle joint, (2) the capsular ligament of the talo-calcanean joint, and (3) the talo-navicular ligament, which is part of the

capsule of the talo-calcaneo-navicular joint. The ligament which is the chief agent in holding it in place is the anterior or interosseous talo-calcanean ligament.

Talo-calcanean Joint.—This is a simple, gliding synovial joint between the large facet on the lower surface of the talus and the corresponding facet on the middle of the upper surface of the calcaneum. It is surrounded by a **capsular ligament**, which is attached to the bones near the margins of the articular facets, and is divisible into *anterior*, *posterior*, *lateral* and *medial talo-calcanean ligaments*. They are composed of short fibres except the anterior ligament, which is commonly called the interosseous talo-calcanean ligament.

The **interosseous talo-calcanean ligament** is a powerful band—thick, wide and flat (Fig. 191). It lies in the sinus tarsi (*i.e.* the tunnel between talus and calcaneum), between the talo-calcanean and talo-calcaneo-navicular joints, forming part of the capsular ligaments of both joints. It is attached to the floors of the grooves on the contiguous surfaces of the talus and the calcaneum.

FIG. 191.—Socket for Head of Talus.

Talo-calcaneo-navicular Joint.—The construction of this joint is peculiar; but, in a way, it is fashioned after the manner of a ball and socket joint. The ball is the anterior part of the talus. The socket (Fig. 191) is made up of (1) the anterior part of the calcaneum, including the sustentaculum tali, (2) the plantar calcaneo-navicular ligament, and (3) the navicular bone.

The **capsular ligament** around the joint is composed of a number of named ligaments continuous with each other at their edges. Thus: the lowest fibres of the *deltoid ligament*

close the joint medially; the *interosseous talo-calcanean ligament* forms the postero-inferior part of the capsule; a band of fibres called the *lateral calcaneo-navicular ligament* closes the joint laterally; and the *talo-navicular ligament* forms the upper part of the capsule.

An examination of different sets of bones will show that, in some cases, a part of the joint is separated from the rest by an offshoot of the interosseous ligament—and that is the part between the body of the talus and the sustentaculum tali.

The **talo-navicular ligament** is a narrow ribbon composed of short fibres that pass across the joint from the upper surface of the head of the talus to the upper surface of the navicular bone.

Dissection. Divide the various ligaments which hold the talus in place, and remove the bone. Clean the divided *interosseous ligament*, and examine its attachment on both the talus and the calcaneum. Examine the socket for the head of the talus; and clean the *lateral calcaneo-navicular ligament* on the lateral margin of the socket.

Examine the *talus*, and note: (1) The large facet on the lower surface for articulation at the talo calcanean joint. (2) The convex anterior surface for articulation with the navicular. (3) An elongated facet on the lower surface of the head, neck and body for articulation with the upper surface of the anterior part of the calcaneum and of the sustentaculum tali; it may be divided by a ridge or by a groove into two parts. (4) A triangular facet, between 2 and 3, for articulation with the spring ligament.

Calcaneo-navicular Ligaments.—Although the calcaneum does not articulate with the navicular bone, it is connected with it by two powerful ligaments, viz., the plantar and lateral calcaneo-navicular ligaments.

The **plantar calcaneo-navicular ligament** or "spring" ligament is a triangular sheet, thick and dense—almost fibro-cartilaginous in texture—that plays an important part in maintaining the longitudinal arch of the foot. It stretches from the anterior margin of the sustentaculum tali to the plantar surface of the navicular bone, and fills up the angular interval between the two bones.

The head of the talus rests on it. The deltoid ligament is attached to its medial margin and braces it up. The tendon of the tibialis posterior is in close contact with it and supports

it inferiorly; and, lateral to that, it is separated only by a little fat from the tendons of the long flexors at their point of crossing each other.

The **lateral calcaneo-navicular ligament** is placed deeply in the anterior part of the depression between the calcaneum and the head of the talus, and is the medial part of a V-shaped band, called the *bifurcated ligament*, which springs from the calcaneum and immediately divides into the lateral calcaneo-navicular ligament and the medial calcaneo-cuboid ligament. The lateral calcaneo-navicular ligament stretches from the anterior part of the upper surface of the calcaneum to the lateral surface of the navicular bone; it is continuous below and medially with the plantar calcaneo-navicular ligament, and superiorly with the talo-navicular ligament.

Calcaneo-cuboid Joint.—In the calcaneo-cuboid joint, the anterior surface of the calcaneum articulates with the posterior surface of the cuboid. It is a distinct joint—that is, its cavity does not communicate with the cavities of neighbouring joints.

The **capsular ligament** surrounds the joint, and is subdivided into three parts, namely, the dorsal and medial calcaneo-cuboid ligaments and the short plantar ligament. The capsule is supplemented, on its plantar aspect, by the long plantar ligament.

The *medial calcaneo-cuboid ligament* is the lateral part of the bifurcated ligament. It springs from the upper surface of the calcaneum immediately in front of the sustentaculum tali and passes to the medial surface of the cuboid bone.

The *dorsal calcaneo-cuboid ligament* is a thin ribbon made of short fibres that pass between the dorso-lateral surfaces of the calcaneum and the cuboid.

The **long plantar ligament** is a long, strong band whose importance in maintaining the arch of the foot is surpassed only by that of the spring ligament.

It has a wide attachment on the plantar surface of the calcaneum, to an area about an inch square, in front of the medial and lateral tubercles. It extends forwards to be attached to both lips of the groove on the cuboid bone, and its superficial fibres are prolonged into slips that are fixed to the bases of the second, third and fourth metatarsal bones. The part of it that bridges across the groove of the cuboid holds the tendon of the peroneus longus in its place, and is called

the fibrous sheath of the peroneus longus. The ligament is to a large extent covered by the flexor accessorius, the flexor digiti minimi and the adductor hallucis, to all of which it gives partial origin.

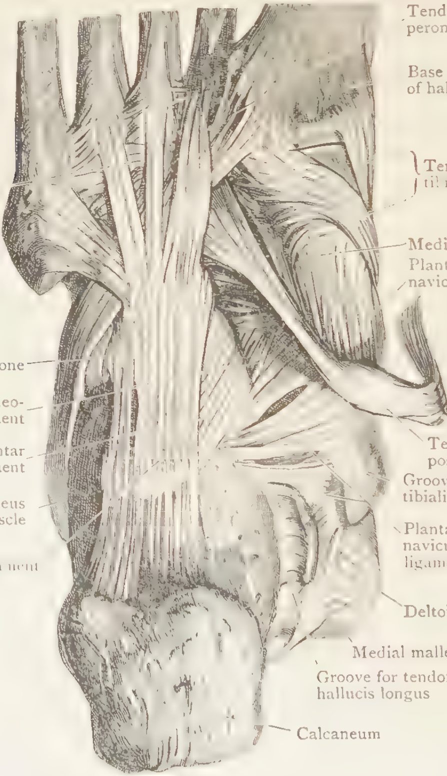


FIG. 192.—Plantar Aspect of Tarsal and Tarso-metatarsal Joints.

Dissection. Define the margins of the long plantar ligament. Slip the knife between the ligament and the anterior part of the calcaneum, and carry it backwards, detaching the ligament from the calcaneum. Throw the ligament forwards, to expose the short plantar ligament, and then clean that ligament.

The *short plantar ligament* (plantar calcaneo-cuboid) is placed under cover of the long plantar ligament all except its medial edge. It is a wide band composed of strong fibres,

nearly an inch in length. They spring from the anterior part of the plantar surface of the calcaneum, and extend to the plantar surface of the cuboid behind its ridge. The ligament is broader than the long plantar ligament and could be seen at the medial border of the latter before it was reflected.

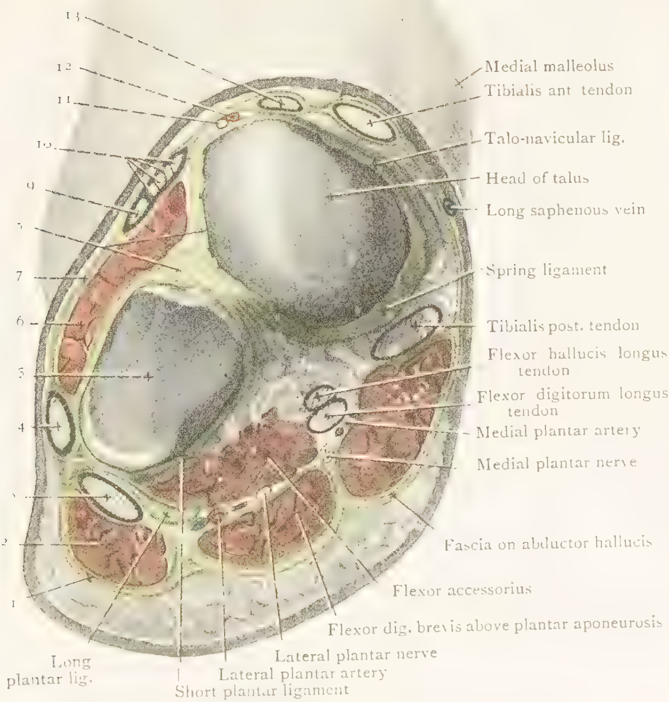


FIG. 193.—Section of the Foot through the Transverse Tarsal Joint.

1. Lateral part of plantar fascia.
2. Abductor digiti minimi muscle.
3. Peroneus longus tendon.
4. Peroneus brevis tendon.
5. Calcaneum.
6. Extensor digitorum brevis.
7. Inferior extensor retinaculum.
8. Bifurcated ligament.
9. Peroneus tertius tendon.
10. Tendons of extensor digitorum longus.
11. Anterior tibial nerve.
12. Dorsalis pedis artery.
13. Extensor hallucis longus tendon.

Transverse Tarsal Joint.—The articulation of the talus with the navicular bone is part of a joint which is quite separate from the calcaneo-cuboid joint ; but those two articulations—the talo-navicular and calcaneo-cuboid—lie very nearly in the same transverse plane (Fig. 190), and are together called the *transverse tarsal joint.* The twisting movements of the foot called *inversion* and *eversion* take place chiefly at this compound joint ; and amputation of the distal part of the foot can be carried out at this joint without the division of any bone. The structures around the joint—which would be cut in such an amputation—are shown in Fig. 193. Note that, owing to the slope of the foot, the talo-navicular joint is above the calcaneo-cuboid joint, as well as medial to it. Note also that the ligaments around the joint are, with one exception, attached posteriorly to the calcaneum. They are :—

Plantar calcaneo-navicular Bifurcated Long plantar Short plantar Dorsal calcaneo-cuboid	Attached to the calcaneum.
Talo-navicular . .	Attached to the talus.

The remaining joints of the tarsus are of less importance, for the bones are so tightly bound together that movement between them is very little.

The **navicular** bone articulates with the three **cuneiform** bones and is united to them by *dorsal* and *plantar ligaments.*

The **cuneiform** bones lie in front of the navicular. They articulate together side by side, and are closely bound by *dorsal, plantar* and *interosseous ligaments.*

The **cuboid** bone lies lateral to the navicular and cuneiform bones. It articulates with the lateral cuneiform bone and, occasionally, with the navicular ; and it is united to both of them by *dorsal, plantar* and *interosseous* ligaments.

Inter-cuneiform Joints.—The three cuneiform bones are held together so firmly that very little individual movement is permitted. The chief uniting structures are *two* strong *interosseous ligaments* which pass between the non-articular portions of their opposed surfaces. *Dorsal* and *plantar inter-cuneiform ligaments* also are present. These are short, flat, transversely-placed bands.

Cuneo-navicular Joint.—The three cuneiform bones articulate with the anterior surface of the navicular bone. They are held in position by *dorsal ligaments*, which pass from the dorsal surface of the navicular to the dorsal surface of each of the cuneiform bones, and by *plantar ligaments*, which are similarly disposed. The plantar ligaments are

stronger than the dorsal ligaments, and are reinforced by slips from the tendon of the tibialis posterior.

Dissection.—Divide freely all the dorsal cuneo-navicular ligaments and the most medial of the plantar ligaments. The navicular bone can then be drawn backwards so as to expose the interior of the joint. The knife may also be carried through the dorsal cubo-navicular ligament and along the lateral side of the lateral calcaneo-navicular ligament. A much better view of this ligament is thus obtained.

The convex, anterior surface of the navicular fits into a transversely concave socket formed by the posterior surfaces of the three cuneiform bones, and, often, by a small facet on the medial surface of the cuboid as well. The articular surface of the navicular is divided by ridges into areas corresponding with the different parts of the socket. The *synovial membrane* of this joint is prolonged forwards into the inter-cuneiform joints.

Cuneo-cuboid and Cubo-navicular Joints.—It has been noted that the anterior pillar of the longitudinal arch of the foot is divided into a lateral and a medial column. The tarsal portions of these are connected together by the cubo-navicular and the cuneo-cuboid joints.

It is only occasionally that the navicular articulates directly with the medial surface of the cuboid. When it does so, the facet on the cuboid lies in series with the articular surfaces on the posterior ends of the cuneiform bones, and forms with them the socket for the navicular. The *ligaments* which bind the navicular to the cuboid are disposed transversely, and consist of—(1) a series of short strong *interosseous* fibres; (2) a *dorsal* band; and (3) a *plantar* band.

The dorsal ligament was divided when the dissector exposed the interior of the cuneo-navicular joint and defined the lateral calcaneo-navicular ligament; but he can display the plantar and interosseous ligaments by pulling the bones apart.

The cuboid, by an oval facet on its medial surface, articulates with the lateral cuneiform bone, forming thereby the *cuneo-cuboid joint*. The two bones are bound together by *interosseous*, *dorsal*, and *plantar ligaments*. Divide the dorsal ligament and insinuate the knife between the two bones in order to find the interosseous ligament. It is the strongest of the three ligaments.

The *synovial* membrane of the cuneo-navicular joint is prolonged into the cuneo-cuboid joint and also into the cubo-navicular joint, when that exists.

Tarso-metatarsal Joints. The bases of the first three metatarsal bones articulate with the three cuneiform bones, and the bases of the fourth and fifth articulate with the cuboid bone. The metatarsal bones are very firmly attached to the cuneiform and cuboid bones by *dorsal*, *plantar*, and *interosseous* ligaments. It is particularly important to note that the line of articulation is irregular, and that the base of the second metatarsal bone is wedged between the medial and lateral cuneiform bones, for the intermediate cuneiform does not reach so far forward as the other two do. (Fig. 165.)

The *dorsal ligaments* are flat, distinct bands which can readily be defined by the careful dissector. *One* such ligament passes to the base of the first metatarsal from the medial cuneiform ; *three*—one from each cuneiform bone — proceed to the base of the second metatarsal ; *one* extends from the lateral cuneiform to the base of the third metatarsal ; *two*—one from the lateral cuneiform and one from the cuboid—go to the base of the fourth metatarsal ; and *one* passes from the cuboid to the base of the fifth metatarsal.

The *plantar ligaments* are not so regularly disposed. Those in connexion with the first and second metatarsal bones are very strong. Some of the bands have an oblique direction ; and those which go to the bases of the second, third, and fourth metatarsal bones are more or less connected with the fibrous sheath of the tendon of the peroneus longus, and, therefore, with the long plantar ligament.

> ***Dissection.***—To bring the *interosseous ligaments* into view, divide the dorsal ligaments, and then forcibly bend the metatarsus plantarwards upon the tarsus. The interosseous ligaments will resist this proceeding ; and, on looking into the joints, the dissector will see them stretched and tense. If the force is continued, they will rupture.

The *interosseous ligaments* are three in number, viz., a medial, an intermediate, and a lateral.

The *medial interosseous ligament* is an exceedingly strong band which passes laterally from the anterior part of the lateral surface of the medial cuneiform bone to the adjacent surface of the base of the second metatarsal bone.

The *intermediate interosseous ligament* is small. It passes between the anterior part of the medial surface of the lateral cuneiform and the adjacent surface of the base of the second metatarsal.

The *lateral interosseous ligament* passes from the lateral surface of the lateral cuneiform bone to the medial side of the base of the fourth metatarsal.

One interosseous ligament, therefore, passes from the medial cuneiform bone and two from the lateral cuneiform ; and of these, two are attached to the base of the second metatarsal bone, and the other to the base of the fourth.

Tarso-metatarsal Articular Surfaces.—The manner in which the metatarsus is implanted upon the tarsus should now be examined.

The *first metatarsal bone* rests against the medial cuneiform bone ; and this joint has a separate synovial cavity.

The *second metatarsal* articulates with the intermediate cuneiform ; but its base is grasped by the anterior parts of the medial and lateral cuneiform bones, with both of which it articulates, and with both of which it is connected by interosseous ligaments. It is not surprising, therefore, that this metatarsal should possess so little power of independent movement, and present a difficulty to the surgeon when he is called upon to amputate the anterior part of the foot through the tarso-metatarsal joints.

The *third metatarsal* articulates with the lateral cuneiform, against which the medial margin of the base of the *fourth metatarsal* also rests.

The synovial membrane of these joints is continuous with that of the joint between the medial two cuneiform bones, and through that with the synovial membrane of the cuneo-navicular joint.

The bases of the *fourth* and *fifth metatarsal bones* articulate with the cuboid. The cavity of the joint is separate from the other tarso-metatarsal joints.

Intermetatarsal Joints.—The bases of the lateral four metatarsal bones articulate with one another, and are very firmly bound together by *dorsal*, *plantar* and *interosseous* ligaments.

> ***Dissection.***—To bring the interosseous ligaments into view, divide the dorsal ligaments and then forcibly separate the bases of the bones from one another.

Joint Cavities of the Foot.—There are six separate joint cavities included in the tarsal, tarso-metatarsal, and intermetatarsal articulations as a whole, viz.—

1. Talo-calcanean.	4. Cuneo-navicular, with extensions.
2. Talo-calcaneo-navicular.	5. Medial cuneo-metatarsal.
3. Calcaneo-cuboid.	6. Cubo-metatarsal, with extension.

The student should particularly note that one of these cavities—sometimes known as the general tarsal cavity—is much more complicated than the others. It is prolonged forwards from the cuneo-navicular joint between the cuneiforms, and also between the cuboid and the lateral cuneiform; moreover, it extends beyond the tarsus and is continuous with the cavities that separate the bases of the second, third and fourth metatarsal bones from the cuneiform bones and from one another.

The interosseous ligament which passes from the third cuneiform (frequently from the cuboid) to the fourth metatarsal bone separates the general tarsal cavity from the cavity between the cuboid and the fourth and fifth metatarsals. This cavity is itself prolonged forwards between the bases of those two metatarsals.

> ***Dissection.***—Remove the abductor, adductor and flexor brevis of the big toe, detaching them from the first phalanx and separating them carefully from the sesamoid bones. Next, divide the deep transverse ligaments of the sole on each side of the second toe (if that has not been done), and trace the tendons of the interosseous muscles of the first two spaces to their insertion into the extensor expansion. Raise the extensor tendons from the joints of the first and second toes, separating them carefully from the synovial membranes. Then, clean the ligaments on the sides and plantar surfaces of those joints.

Metatarso-phalangeal Joints.—These joints are formed between the heads of the metatarsal bones and the bases of the

proximal row of phalanges. The base of the phalanx articulates with the distal or anterior surface of the head of the metatarsal when the joint is in the extended position, and with the plantar surface of the head when the joint is flexed.

The ligaments of each joint are a capsular ligament, two collateral ligaments and a plantar ligament.

The **capsular ligament** surrounds the joint, and is attached to the bones near the margins of the articular surfaces. It is thickened at the sides to form the collateral ligaments; its plantar part is greatly thickened to form the plantar ligament; its dorsal part is exceedingly thin, and is fused with the extensor tendon, so that the extensor tendon is, in effect, the dorsal ligament of the joint and is lined with the synovial membrane.

Each *collateral ligament* is a thick, triangular band whose apex is attached to the pit and tubercle on the side of the head of the metatarsal bone. From that attachment, its fibres radiate to the side of the base of the phalanx and to the margin of the plantar ligament.

The *plantar ligament* is a thick, dense, fibrous plate. It forms part of the socket for the head of the metatarsal bone and articulates with the plantar surface of the head when the joint is extended. It is attached firmly to the base of the phalanx, and loosely to the neck of the metatarsal bone; during flexion and extension, it therefore moves with the phalanx. Its margins give attachment to the fibrous flexor sheath, to the slips of the plantar aponeurosis and to the deep transverse ligaments of the sole. It forms part of the tunnel for the flexor tendons; its plantar surface is therefore concave from side to side, and is lined with the outer layer of the synovial flexor sheath.

The plantar ligament of the first metatarso-phalangeal joint is almost all replaced by the sesamoid bones of the two tendons of the flexor hallucis brevis, which groove the plantar surface of the head of the metatarsal bone. Minute sesamoid nodules are developed occasionally in the plantar ligaments of some of the other joints. The first metatarso-phalangeal joint is much the largest, owing to the size of the bones, and the presence of the large sesamoids.

Dissection. Pull the extensor tendons out of the way; divide the synovial membrane on the dorsum of the joint and the collateral ligaments at the sides. Flex the toe; examine

the attachments of the plantar ligament, and note the sesamoid bones that replace it in the joint of the big toe.

The metatarso-phalangeal joints are condyloid joints, permitting flexion, extension, abduction, adduction and circumduction, but not rotation. Flexion and extension are brought about by the long and the short flexors and extensors, the flexors being aided by the interossei and the lumbricales. Abduction and adduction take place from and to the middle line of the second toe ; and are carried out by the interossei and by special abductors and adductors. The big toe has its own abductor and adductor. The three plantar interosseous muscles adduct the third, fourth and fifth toes towards the second. The first and second dorsal interossei alternately abduct and adduct the second toe from and to the line that bisects it. The third and fourth toes are abducted from the second by the third and fourth dorsal interossei ; the little toe has its own abductor.

Inter-phalangeal Joints.—These are constructed on the same plan as the metatarso-phalangeal joints. The base of the distal bone articulates with the distal surface of the head of the proximal bone in extension, and with the plantar surface in flexion. The *capsular ligament* is strengthened to form *collateral* and *plantar ligaments* ; its dorsal part is fused with the extensor tendon. The plantar ligament is fixed firmly to the base of the distal bone and loosely to the neck of the proximal bone ; it articulates with the plantar surface of the head in extension and it moves with the distal bone ; it forms part of the wall of the digital tunnel, and the thin, weak part of the fibrous flexor sheath is attached to its margins.

An interphalangeal joint is a simple hinge joint, permitting only flexion and extension ; movements sideways are prevented by the pulley-shaped head of the proximal bone and the tightness of the collateral ligaments. In the lesser toes, at rest, the joints are, to a varying degree, in a state of partial flexion. The interphalangeal joint of the hallux is operated on by the long extensor and long flexor. The interossei and the lumbrical muscles are the chief agents in extending the joints of the other toes ; the distal joint is flexed by the long flexor, and the proximal joint by the short flexor aided by the long flexor.

Hallux Valgus and Hammer-Toe. The first metatarso-phalangeal joint is often enlarged and deformed with

permanent lateral displacement of the big toe. This condition, known as *hallux valgus*, is more common in women than in men; and dissectors should take any opportunity that presents itself in the dissecting room to examine the relations of the parts in such cases.

Owing to the lateral displacement of the toe, the head of the first metatarsal projects on the medial border of the foot; very frequently, as a result of boot pressure, an *adventitious bursa* is formed over it; such a bursa, becoming inflamed, produces a painful swelling—a *bunion*.

The flexor tendons and the sesamoid bones are displaced laterally, and the head of the metatarsal and the sesamoids are often enlarged and irregular from osteo-arthritis.

In *hammer-toe*, the toe (usually the second) is permanently dorsi-flexed at the metatarso phalangeal joint, and the normal flexion at the inter-phalangeal joints is accentuated. The flexor tendons and the plantar ligaments of these joints are permanently shortened.

INDEX

END OF VOL. I